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US Army Corps
of Engineers®

Jacksonville District

Design Manual

Draft

PREFACE

This Jacksonville District Design Manual prescribes standard procedures and instructions for the preparation of design documents for Civil and Military construction projects under the direction of the US Army Corps of Engineers (COE), Jacksonville District.

Where conflicts exist between this document and contractual documents for design services, the contractual documents take precedence.

The electronic version of this manual is available on the Jacksonville District home page.

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T A B L E   O F   C O N T E N T S

CHAPTER 1

GENERAL INSTRUCTIONS

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CHAPTER 1

GENERAL INSTRUCTION

1.1 GENERAL

The Jacksonville District Design Manual prescribes standard procedures and instructions to accomplish the required design analyses, drawings, specifications, cost estimates, and related support tasks for Civil and Military construction projects under the direction of the US Army Corps of Engineers (USACE), Jacksonville District.

This manual is intended to define the typical design phase requirements for each component of work, and does not define all design related considerations.

This manual applies to District personnel, Architect-Engineer (A-E) firms, and other Government agencies and contractors involved in the design and construction of facilities for which the Jacksonville District is responsible.

This manual assumes the use of a Scope of Work (SOW) to clearly identify all components of work. The term d*esigner* may refer to Government or contractor personnel.

The procedures and instructions in this manual will be referenced in all A-E contracts where applicable. The SOW for a given A-E contract will provide project specific criteria and will, in the case of all conflicts, take precedence over the standard procedures and instructions in this Manual. Conflicts will be brought to the attention of the Jacksonville District Project Engineer (PE).

A-E design and engineering studies and services will be in accordance with Public Law 92-582, which enacted the Brooks Bill. However, contracting and administration of A-E design services are not part of this manual.

1.2 APPLICABLE PUBLICATIONS

Design services will employ all applicable U.S. Army Corps of Engineers (USACE) standards for design and preparation of plans, specifications and other supporting documents. The designer is responsible for obtaining all publications. Publications of the Headquarters, United States Army Corps of Engineers are available at: http://www.usace.army.mil/usace-docs/. Deviations from the requirements of Government design standards must be pre-approved in writing by the Contracting Officer or Contracting Officer's Representative (COR).

Design services will also employ applicable state/commonwealth standards, including:

South Florida Water Management District. Permit Information Manual, Volume IV - Management and Storage of Surface Water.

State of Florida, Florida Department of Transportation. Standard Specifications for Road and Bridge Construction, 1999 edition.

South Florida Building Code, latest edition, Volumes I & II.

1.3 INSTRUCTIONS

1.3.1 Health and Safety Standards

The designer shall incorporate the facility, system, and equipment design standards of the Occupational Safety and Health Act, Code of Federal Regulations, Title 29, Chapter XVII, Parts 1910 and 1926, into all engineering design and analyses. The latest versions of the Life Safety Code and the NFPA Code shall also be employed. Conflicts between these standards and other technical criteria shall be promptly submitted to the PE for resolution.

1.3.2 Physically Handicapped Access

All facilities shall be designed to be accessible to, and usable by, handicapped persons in accordance with the Uniform Federal Accessibility Standards (UFAS), American with Disabilities Act (ADA), and NFPA Life Safety Codes, unless specifically stated otherwise in the SOW.

1.3.3 Surveys

The designer shall obtain the boundary, topographic, hydrographic, utility surveying and mapping data required to properly design the project, unless otherwise specified in the SOW. The chapter 5 titled SURVEYING AND MAPPING provides specific instructions.

1.3.4 Foundation Investigations

The designer shall obtain the foundation investigation (including soil and rock borings, sampling, laboratory testing, and pile load tests, where applicable), as well as tests such as percolation tests for septic tanks, soil resistivity tests for grounding and cathodic protection systems and infiltrometer test for storm water detention ponds, unless otherwise specified in the SOW. The chapter 6 titled GEOTECHNICAL provides specific instructions.

1.3.5 Environmental Regulatory Permits

The Government will conduct investigations to delineate wetlands and identify the habitat of endangered species. The designer shall contact the appropriate Federal, State, local, and interstate pollution and environmental control agencies to determine the permits required and the procedures and documentation necessary to obtain them.

1.3.5.1 Civil works projects.

The Government will prepare applications and perform any agency coordination that is necessary to secure environmental and water quality certification permits.

1.3.5.2 Military projects.

Where formal documents are required to be submitted to obtain permits, the designer shall prepare all such documents and provide them in a "ready for signature" condition. This includes necessary copies of the plans, specifications, design analyses, and other required supporting documentation. After review and comment incorporation, the corrected documents will be submitted to the appropriate agency. Permit requirements shall be ascertained and documented by the designer during the Concept Design stage.

The designer shall provide the following information and data for each required permit with the Concept submittal:

(1) Permitting authority (State, local, etc.).

(2) Type of permit required (construction, operation, etc.).

(3) Procedure and time necessary to complete the permit application.

(4) Fees required.

(5) Statement that the project is covered by variances or that permits are not required. If a variance is required, the procedures for obtaining the variance shall be provided. If a permit is not required, reasons and supporting justification (i.e., cite State, local, and/or other regulations) shall be furnished.

(6) An evaluation of all State and/or local regulations to determine if monitoring devices are needed. Where required, monitoring devices shall be included in the project design.

The designer shall provide the completed permit applications not later than the Preliminary submittal or 60 days prior to the Final submittal, whichever is earlier. Permit applications shall be ready for signature by the appropriate official and submission to the approving authority.

With the Final submittal, the designer shall provide all supporting documents, plans, and specifications. By this time, the designer shall also have accomplished the necessary coordination to obtain permit application approvals.

1.4 DEFINITIONS

1.4.1 Design Documentation Report

For civil works projects, a Design Documentation Report (DDR) shall be provided with each submittal. The content and format of this report must conform with requirements contained in Appendix D of ER 1110-2-1150, *Engineering and Design for Civil Works Projects*. Complete computations, Independent Technical Review comments and certification statements; documentation of Quality Control reviews; and minutes of meetings will be incorporated into the DDR, as separate appendices. The DDR shall also contain copies of site visit reports and all records of discussions.

1.4.2 Design Analysis

For military projects, a Design Analysis (DA) shall be is provided with each submittal. The content and format of this report must conform with requirements contained in ER 1110-345-700, *Design Analysis, Drawings, and Specifications*.

1.4.4 Life-Cycle Cost Analyses

Life-cycle cost analyses are engineering economic studies which consider the potential economic impact of time on alternate systems, subsystems, and components over a given life cycle. A Life-Cycle Cost Analysis provides a means to determine the total cost of each alternate by considering not only the initial cost of construction but also the costs associated with operation and maintenance over a given life-cycle.

1.5 SUBMITTAL REQUIREMENTS

1.5.1 General

Submittal documents to be reviewed at each design phase are listed below. Specific instructions for submittal requirements are provided in the SOW.

1.5.2 Project Definition (10-15%)

This submittal represents approximately 10 to 15% of the design effort and shall validate requirements and develop schematic designs.

1.5.3 Concept Design (30-35%)

This submittal represents approximately 30 to 35% of the design effort and shall be of sufficient detail to show how the users' functional and technical requirements will be met, indicate the designer's approach to the solution of technical problems, show compliance with design criteria or provide justification for noncompliance, and provide a valid estimate of cost. The Concept Design consists of:

(a) Design Documentation Report or Design Analysis.

(b) Concept drawings.

(c) Bidding schedule.

(d) Concept cost estimate.

(e) Required information and data for each required permit.

1.5.4 Preliminary Design (50-65%)

This submittal, if required, is primarily to insure that funding limitations are not being exceeded and that the drawings, specifications, design analysis, and cost estimate are proceeding in a timely manner and that the design criteria and previous review comments are being correctly interpreted. The Preliminary Design consists of:

(a) Design Documentation Report or Design Analysis.

(b) 60% complete drawings.

(c) Outline Specifications

(c) 60% Cost estimate.

(d) Annotated Concept review comments.

(e) Completed permit applications (if an Preliminary submittal was not required, the completed permit applications are required 60 days prior to the Final submittal).

1.5.5 Final Design (unreviewed 100%)

This submittal represents a 100% complete design with the exception of the incorporation of any review comments resulting from the review of the submittal. The Final Design consists of:

(a) Design Documentation Report or Design Analysis with all items l00% complete. The document shall include all backup material previously submitted and revised as necessary, all design calculations, all explanatory material giving the design rationale for any design decisions which would not be obvious to an engineer reviewing the Final drawings and specifications, and complete notations for Construction Manager.

(b) 100% complete drawings.

(c) Specifications.

(d) Bidding schedule.

(e) Detailed 100% complete cost estimate.

(f) Annotated Preliminary review comments.

(g) Lessons Learned Certification for each discipline.

(h) All supporting documentation required for permit application approvals.

1.5.6 Corrected Final

This submittal represents a 100% complete design including the complete incorporation of all review comments resulting from the review of the Final submittal.

CHAPTER 2

PRESENTATION OF DATA

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CHAPTER 2

PRESENTATION OF DATA

2.1 GENERAL

All documents will be legible and clearly expressed. Each submittal required by this manual for review shall be titled and dated, and will include a cover sheet that indicates the design phase. Pages within a section or chapter of a document shall be consecutively numbered and indexed so that specific information can be easily located. Specific submittal requirements, including the number, size, and format of each document, will be addressed in the SOW.

2.2 APPLICABLE PUBLICATIONS

TR-CADD-99	A/E/C CADD Standards, latest release http://tsc.wes.army.mil/products/standards/aec
ER 1110-2-1150	Engineering and Design for Civil Works Projects
ER 1110-345-700	Design Analysis, Drawings, and Specifications

2.3 DOCUMENT REVIEW AND COORDINATION

The designer shall check and coordinate each submittal for omissions, to avoid repetition, and to identify and resolve conflicts. The designer shall prepare the drawings and specifications with the expectation that the construction contractors shall be able to complete construction without any additional assistance or issuance of modifications to correct design deficiencies. Details of standard products or items which are adequately covered by specifications will not be included on the drawings. However, drawings will be detailed to the extent that an accurate cost estimate can be prepared and shop drawings can be checked. Coordination among disciplines and between drawings and specifications is essential.

Guide specifications contain notes with design information to the specifier and designer. These notes include restrictions and guidelines on the selections of materials and of construction methods and may include details and information that must be shown on drawings. The designer shall examine these notes, and check the drawings and other submittal data to be sure they are coordinated with the specifications.

2.4 DRAWINGS

Drawings shall be prepared in a manner that clearly and adequately delineates the work to be accomplished by the construction contractor. Care should be taken to eliminate conditions and avoid practices that might delay the work or result in disputes and subsequent claims. All drawings will be created using Computer Aided Design (CADD) technology and shall conform to the Tri-Service A/E/C CADD Standards, latest release. These CADD standards are available at http://tsc.wes.army.mil/products/standards/aec Additional criteria for preparation of drawings is contained in ER 1110-2-1200, *Plans and Specifications for Civil Works Projects*.

2.4.1 Supplemental CADD Standards.

The following standards and instructions represent Jacksonville District preference, and, in the event of conflict, take precedence over other requirements.

Full-sized drawings shall be developed as “F” sized sheets (41” x 29” at the trim line) and utilize the standard Corps of Engineers Jacksonville District title block. Half-sized drawings are to be provided on 20½” x 14½” (at the trim line) sheets.

One CADD (*.DGN) file shall be used per drawing (sheet file). Reference files should be used liberally during the design development. Sheet files shall contain only information which pertains to the specific drawing sheet. Other design and drawing information, in particular information common to multiple sheet files, shall be included through the use of referenced model design or raster files.

The primary subject be will drawn full scale. The title block template (border file), used as a reference file, shall be scaled as appropriate.

Generic text in the title block file is intended to be edited as appropriate for a specific project. Title block/borders shall be referenced to the sheet files using the saved view contained in the border file. Text in color green (2) is common to all sheets in the project and shall be edited to reflect that condition. Text in color orange (6) shall be used for sheet specific information and will require the coping of those text elements into the active design file. Element attributes within the title block file must not be changed. The trim line shape element attributes are used for batch plotting processes.

Font symbology shall be created by using the corps.rsc font file. No non-corps fonts shall be used. Font 8 shall be used for all leader type notes and dimension text, etc. Font 10 shall be used for all stacked or columnar text. Font 9 shall only be used for hydrographic/hydraulic text such as water flow information, etc. Other fonts may be used in special circumstances such as Block Outline, Corps Bold or Compressed for special cover sheet titles. Designs for roadways specifying compliance to Florida Department of Transportation (FDOT) Standards shall incorporate the FDOT font symbol libraries.

Files shall be named using the A/E/C CADD Standard convention found in Chapter 2, Figure 6.

All designs which depict the geographic locations of objects shall be located according the State Plane Grid System annotating the State Plane Zone and datum (whether shown in Horizontal NAD 83 or NAD 27, and Vertical NGVD 29 or NAVD 88), as specified by the Project Engineer. The first drawing in a series showing geography shall contain a note defining the projection, datum, survey number, surveyor name, and date. Design files depicting geographic locations shall be created using three-dimension seed files with the global origin located at the lower left corner on the design cube and the "z" origin in the center of the design depth of the design cube.

Electronic submittals shall be on standard compact disc, and include both the Microstation design files and the reference files (survey process files, digital terrain model files, XYZ files, etc.) Reference files shall be submitted in the same directory as the design files. All reference files must have relative paths. No full paths should be saved.

2.4.2 File Number

A Jacksonville District Office (DO) file number will be issued by the PE for each set of project drawings. This number will appear in each titleblock.

2.4.3 Units

Unless specified otherwise in the SOW, drawings will be prepared using English units of measurement.

2.4.4 Key Plans

When plans of large buildings or structures must be placed on two or more sheets to maintain proper scale, the total plan shall be placed on one sheet at a smaller scale. Appropriate key plans and match lines shall appear on segmented drawings. Key plans shall be used to relate large-scale plans to total floor plans and individual buildings and complexes of buildings. Key plans shall be placed in a convenient location and shall indicate represented plan area by crosshatching.

2.4.5 For Information Only Drawings

When drawings from previous contracts are deemed necessary for information purposes only, the words "FOR INFORMATION ONLY" shall be printed in bold letters immediately above the title block or as near thereto as practical. The original title blocks shall not be changed. For filing purposes, the Jacksonville District file number for the project shall be printed in the margin below the title block. All information only drawings shall be identified as such and listed in the Index of Drawings.

2.4.6 Plan Set Revisions

Drawing revisions during the contract advertisement period are amendments. Revisions after award of a construction contract are modifications.

2.4.6.1 Individual Drawing Revisions

All revisions shall be flagged by a teardrop symbol. The teardrop symbol should be positioned adjacent to the change or revision with the tip of the teardrop placed towards the detail, plan, section or diagram. Teardrop symbols shall be sequentially alphabetized. The total number of teardrops for a revision and a short description shall be placed in the revision block. Filenames will remain unchanged. The drawing index sheet shall be updated to include a teardrop symbol at the index listing for that drawing.

2.4.6.2 Added or Deleted Drawings

When drawings are added to or deleted from an existing advertised/awarded contract project, a teardrop symbol shall be placed on the index of drawings sheet adjacent to the added drawing. For deleted drawings, a line should be drawn through the index listing for that drawing with the word "deleted" inserted at the end of the title. The revisions block of the index sheet should also be flagged and the addition/deletion noted.

CHAPTER 3

SPECIFICATIONS

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CHAPTER 3

SPECIFICATIONS

3.1 GENERAL

Specifications shall be prepared in accordance with ER 1110-1-8155, *Specifications*. Project specifications, when combined with contract drawings, will provide sufficient detail to clearly portray all project requirements, and that ensure the project is constructed in accordance with approved and established engineering standards and design requirements.

Specifications prepared by the designer must be accurate, clear, and precise and should not be subject to interpretation. The specifications will be specific, free of ambiguities, and well coordinated with the drawings. The designer shall be solely responsible for insuring the relevancy and accuracy of cross-references between technical sections of the specifications.

Specifications shall not reference USACE standards, with the exception of EM 1110-1-2909, *Geospatial Data and Systems*, and EM 1110-2-1003, *NAVSTAR Global Positioning System Surveying.*

3.2 AUTOMATED SPECIFICATIONS

Designers shall use SPECSINTACT software, an automated specification system, for preparation of project specifications. This software is available from the National Aeronautics and Space Administration: http://si.ksc.nasa.gov/specsintact/.

3.3 GUIDE SPECIFICATIONS

Designers shall use the Unified Facilities Guide Specifications (UFGS) for all sections for which no Jacksonville District master guide specification exists. The structure of UFGS is consistent with the Construction Specification Institute's MasterFormat, and is organized on the basis of materials and methods of construction. UFGS are available at: http://www.ccb.org/ufgs/ufgs.htm.

Use of Jacksonville District master guide specifications, which take precedence over UFGS, is mandatory when required in the specifications. These guide specifications are available at: http://www.saj.usace.army.mil/cadd/endcweb.htm

The version of the guide specifications available at the Preliminary Design submittal shall be used for the Final Design submittal.

3.3.1 Division 00: Documents

Bidding requirements and contract clauses are not, by definition, specifications, but are typically packaged with the specifications as a convenience for project contract document assembly.

The designer shall provide the project bidding schedule that includes all required payment items. See Aids to Advertising below. The Jacksonville District will retain responsibility for the remaining bidding requirements and contract clauses.

3.3.2 Division 01: General Requirements

The Project Engineer will provide the designer with Jacksonville District project preferences to be incorporated into Division 01. This information may include the construction contract performance period, liquidated damages, Government personnel accommodations, Government Quality Assurance Representative field office requirements, contractor furnished radios and vehicles for Government personnel, Contractor Quality Control staffing requirements, and specific guidance on environmental protection plans and turbidity monitoring. The designer will obtain all other information necessary to complete Division 01 specification sections. Where this information is not provided, the designer shall determine these items in best interest of the Government.

3.3.2.1 Section 01000, General Requirements

The following are data sources for selected paragraphs in Section 01000, General Requirements.

- Water level and flow information can be obtained from the United States Geological Survey (USGS)at http://water.usgs.gov/. Select “Water Data” to get daily flow and peak stage flow information for the appropriate locations. Water data is also available on compact disk from commercial vendor, CLIMDATA.

- Rainfall data, published by National Oceanographic and Atmospheric Administration (NOAA), can be obtained at http://www.ncdc.noaa.gov/. Adverse weather day data methodology is based on Engineering Regulation ER 415-1-15, *Construction Time Extensions for Weather*. The designer will determination of the number of days in each calendar month when rainfall equals or exceeds 0.1 inch. Rainfall data is also available on compact disk from commercial vendor, CLIMDATA.

- Tidal data can be obtained from the National Ocean Service at http://www.opsd.nos.noaa.gov/. Select “benchmarks” and then the region of interest.

The designer shall also prepare an “Order of Work” clause, if required, describing the required sequence of construction operations for this project and insert that clause in Section 01000.

3.4 ORIGINAL SPECIFICATIONS.

The designer must edit and adapt UFGS to satisfy the project requirements and provide a complete set of construction specifications. In instances where there are no appropriate guide specifications available for use, the required specifications will be prepared by the designer using SPECSINTACT. These specifications shall list the essential features, functions, and other factors to clearly indicate the type and quantity of items/work required. These specifications must match the UFGS specifications in format and document arrangement.

3.4.1 Functional Specifications. Functional or descriptive specifications are normally prepared using industry standards, manufacturer's data, and other available information. These specifications will be developed by listing parameters, methods, techniques and other requirements that several manufacturers can satisfy. These specifications will list the essential features, requirements, minimum functions, and other factors to clearly indicate the type and quality of item(s) required. Specifications should not be developed based on the requirements of a single manufacturer.

3.4.2 Sole Source Specifications. Specifying by brand or manufacturer's name will be avoided. The use of trade names and proprietary items and the drafting of a specification by adopting a manufacturer's description of a particular article or procedures will be avoided. For instances when only one manufacturer's product will satisfy job conditions, the designer shall provide written "Sole Source Justification" to the Project Engineer.

3.4.3 "Or Approved Equal" Specifications. A "trade name or approved equal" description will be avoided. When unavoidable, the salient features of the item(s) used to determine equality will be clearly stated.

3.5 OUTLINE SPECIFICATIONS.

The designer shall develop an outline specification listing the proposed guide specifications and designer prepared sections to be used for the project. The outline specification will list the guide specification number and title for each proposed section. Sections shall be arranged within their respective divisions, in numerical order. New specification sections, developed by the designer, will be numbered to fall in their respective division at a logical location.

3.6 AIDS TO ADVERTISING.

The designer will furnish to following aids to advertising.

a. Final Design Submittal:

(1) Estimate of Construction Time. The designer shall furnish an estimate of the time to construct the project. Consideration will be given to construction contractor procurement of materials and any associated lead time, sequence of construction, anticipated climatic conditions to be encountered during construction, etc.

b. Corrected Final Design Submittal:

(1) List of Drawings. The designer shall furnish a list of drawings, including drawing numbers, titles, and the most current release date. Drawing titles must match exactly the titles on the individual drawings.

(2) Bidding Schedule. The designer must coordinate the bidding schedule with the Jacksonville District Cost Estimating Branch prior to submittal.

(3) Table of Contents. The designer shall prepare a Table of Contents indicating all Division 00 to 16 sections submitted.

(4) List of Government-Furnished Equipment, including description, weight, size, quantities, and approximate value, if applicable.

(5) Information Concerning Salvageable Material, if applicable.

(6) Special Provisions Covering Unusual Situations, i.e. outages, security and/or safety requirements, storage area, construction sequences and phasing requirement (if applicable), access to site, early completion dates, etc.

3.7 AMENDMENTS AND MODIFICATIONS.

The designer will prepare changes in the specifications as a result of discrepancies, oversights, errors, or omissions at no additional cost to the Government. Revised specifications shall be submitted to the Project Engineer in electronic format in time period judged reasonable for the level of effort required to incorporate the necessary changes.

CHAPTER 4

SITE DEVELOPMENT

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EXHIBITS

CHAPTER 4

SITE DEVELOPMENT

4.1 GENERAL

4.1.1 Scope

This chapter states criteria, requirements, and guidance for civil design. The design shall be accomplished in accordance with appropriate manuals and pamphlets and with basic criteria furnished in Statement of Work.

4.1.2 Quality of Design

It is the purpose of the COE to obtain excellent siting and civil design resulting in efficient and economical paving, grading, and drainage conditions.

4.2 APPLICABLE PUBLICATIONS

AFR 88-15	Criteria and Standards for Air Force Construction
AFJMAN 32-8008	General Provisions for Airfield/Heliport Pavement Design
AFI 32-1042	Standards for Marking Airfields
EM 1110-2-410	Design of Recreation Areas and Facilities, Access and Circulation
TM 5-803-5	Installation Design
TM 5-820-4	Drainage and Erosion Control - Drainage for Areas other than Airfields
TM 5-822-2	General Provisions and Geometric Design for Roads, Streets, Walks and Open Storage Areas
EIRS Bulletin 81-05	Dimensions for Typical POV Parking Areas
TM 5-822-5	Pavement Design For Roads Streets, Walks, and Open Storage Areas.
TM 5-822-7	Standard Practice for Concrete Pavements
TM 5-822-8	Bituminous Pavements - Standard Practice

4.3. PROJECT DEFINITION (10-15%)

The Designer shall develop a conceptual site plan, which encapsulates the project requirements. The plan should be an efficient layout with emphasis given to user requirements. The plan shall show building locations, parking areas, roads, limits of paving and hardstands, and pedestrian access points. The plan shall be developed so that a preliminary cost estimate can be prepared.

4.4. CONCEPT DESIGN REQUIREMENTS (30-35%)

4.4.1. Concept Design Analysis

Provide information concerning the following, as applicable:

4.4.1.1. General

a. General overview of major site features planned, such as building orientation, drainage patterns, parking provisions, traffic circulation, provisions for the handicapped, security requirements, airfield pavement work, etc.

b. Provide a description of any locations of wetlands, historically significant areas, or areas with endangered species of wildlife within the project site area.

c. Provide applicable State/local flood requirements.

d. Discuss existing site features including general topography, acreage, boundaries, adjacent site usage, etc.

e. Discuss impacts of new construction on existing facilities.

4.4.1.2. Removals

a. Preliminary discussion of items requiring removal or relocation.

b. Method and location of the disposition of waste or salvage materials

4.4.1.3. Geometry

a. Provide rationale for locating major site elements.

b. Airfields: Provide list of specific clearances based on airfield criteria and list reference manual(s) for all portions of the new work.

c. Work Other Than Airfields. Provide set back requirements or specific clearance requirements for major features of work, such as buildings, parking areas from streets, hardstands, etc.

4.4.1.4. Storm Drainage

a. Provide a summary of Specific State and/or local stormwater permit requirements for water quality/quantity for the project. Discuss the impacts on the site design. If no stormwater permits or requirements are required provide a statement to that effect. Provide documentation from the appropriate regulatory agency.

b. Discuss the preliminary stormwater design scheme and discuss impacts on the existing stormdrain systems.

c. Provide selected design values to be used in the storm drainage calculations such as surface runoff coefficient, retardance coefficients, infiltration rate, and rainfall intensity based on a 10-year and the 100-year storm frequency.

d. Provide preliminary sizes of stormdrain pipes.

e. Provide preliminary size and preliminary calculations for required stormwater treatment/storage ponds. Discuss impacts on the project site.

f. Provide preliminary Pre and Post construction discharge values for the 10-year & 100-year storm event.

g. Discuss the proposed stormdrain pipe materials.

4.4.1.5. Grading

a. Discuss existing site features affecting grading such as buildings, streets, curbs, walks, fences, water courses, ponds, elevation of high water, rock outcrop, etc.

b. Provide minimum elevation to provide flood protection (if applicable).

c. Planned finished floor elevation.

d. Cut or fill requirements and rough estimate of quantities.

e. Discuss minimum and maximum slopes to be used in the design for embankments, ditches, pipes, etc.

4.4.1.6. Pavement Structure Design

a. Vehicular Pavements Thickness Design.

(1) Specific design values for which pavement thickness is based including the number, type, and maximum weights of vehicles, category of traffic, class road or street, and resulting design index.

(2) Flexible Pavements - required thickness of base and pavement (7-1/2 inch (19cm) minimum) based on the design index and established subgrade CBR.

(3) Rigid Pavements - required thickness of nonreinforced concrete pavement (6-inch (15cm) minimum) based on a 28-day flexural strength concrete of 650 psi and the established modulus of subgrade reaction.

b. Aircraft Pavement Thickness Design. Design and Review Section DR of the Jacksonville District Corps of Engineers shall prepare all airfield pavement structures and materials specification. (This information shall be provided to the A-E if the project is being designed under contract.)

(1) Flexible Pavements - specific design values for which pavement thickness is based including the airfield class, type traffic area, gross weight of aircraft, number of passes, subgrade CBR, and resulting minimum thickness of base and pavement.

(2) Rigid Pavements - specific design values for which the pavement thickness is based including the type of aircraft gear, gear design load, modulus of subgrade reaction or resultant modulus of both subgrade and base course, flexural strength of concrete, and resulting pavement thickness.

(3) For project requiring airfield pavement, the designer shall coordinate with Jacksonville District Geotechnical Branch for required material investigations and specification requirements. Notification of the proposed pavements should be given the PE as soon as possible so as to allow time for any needed sampling.

c. Discuss the proposed base course type and select subgrades. Provide intended compaction requirements.

4.4.1.7. Road and Streets, and Parking Areas

a. Provide listing of traffic volumes and vehicle types.

b. Provide AASHTO design vehicle for which turning movements are to be provided for and corresponding minimum turning radius.

c. Provide project design speed.

d. Provide maximum degree of curvature and control grades.

e. Provide sight and stopping distance requirements.

f. Provide lane and shoulder widths.

g. Provide cross-slopes for lanes and shoulders.

h. Embankment slopes.

i. Requirements for curbs, sidewalks, guardrails, traffic signs and markings, fencing, etc.

j. Rights-of-way and easements

4.4.1.8. Parking and Open Storage Areas

a. Type vehicles to be accommodated

b. Size of individual parking spaces and number to be provided

c. Number and location of handicapped parking spaces

d. General location of parking or storage areas

e. Location of ingress and egress

f. Pedestrian access

g. Use of 90°, 60°, or 45° parking and relation to traffic operation

4.4.1.9. <u>Miscellaneous Site Features</u>

a. Curbs, and curbs and gutters - types and locations

b. Sidewalks - width, and locations

c. Fencing - justification, type, size and location of gates

4.4.1.10. <u>Railroads</u>

a. Type of service for which track shall be provided.

b. Anticipated volume

c. Maximum grade and degree of curvature

d. Features of track construction such as thickness and type of ballast, weight of rail, dimension of ties, size of turnouts, etc.

e. Special requirements for track scales, bumpers, signals, grade crossings, derailers, etc.

4.4.1.11. <u>NPDES Construction Permit</u>

Provide specific requirements for NPDES Construction Permit for the project.

4.4.1.12. <u>Erosion and Sediment Control Plan</u>

Describe intended design of sediment and erosion control for the project.

4.4.1.13. <u>Outline Specifications</u>

List all Corps of Engineers Guide Specifications.

4.4.1.14. <u>Additional Information</u>

List additional information or criteria needed for design.

4.4.2. Concept Drawings (35% Submittal)

Provide the following.

4.4.2.1. Location and Vicinity Maps

a. Indicate project site. Provide preliminary borrow and spoil areas, haul routes, and contractor’s access to the site.

b. Provide State vicinity map.

c. Provide Location map for local access to project site.

4.4.2.2. Geometric Layout Plan

a. Provide an overall site plan showing total development.

b. Show the proposed geometry of the site plan using a minimum scale of l" = 30'(1:500), unless otherwise directed. Include the existing topography without contours that shall remain after construction.

c. Use graphic symbols to distinguish new and existing site work, and provide legend to define graphic symbols.

d. Provide sufficient geometric information to adequately locate all new major site elements.

e. Identify the grid state system used. Include a north arrow.

f. Provide centerline stationing for all roads, streets, parking areas, runways, taxiways, etc.

4.4.2.3. Grading and Drainage Plan

a. Show the complete drainage concept using either finished contours or slope arrows include preliminary storm drainpipe sizes.

b. Use a minimum scale of l" = 30' (1:500), unless otherwise directed.

c. Show and identify all existing buildings and facilities on plan.

d. Show the proposed finished floor elevation and critical spot elevations.

e. Provide control monuments, list horizontal and vertical data for each.

f. Reflect existing utilities with the topography. If necessary for clarity, show removals, relocations, and new work for utilities on separate plans.

g. All contour intervals shall be 1 foot (25cm), unless otherwise directed.

4.4.2.4. Removal Plan

a. Indicate items to be removed.

b. Pavement structures: Indicate pavement layer thickness for removal depths.

4.4.2.5. Centerline Profile

a. Airfields: Provide preliminary profile for runway and/or taxiway centerlines. Provide edge of pavement profiles if applicable for milling and overlay projects. Show existing ground line and preliminary new finish grade with percent new grades indicated.

b. Roads, Streets, & Parking Areas: Provide preliminary profile for centerlines. Show existing ground line and preliminary new finish grade with percent new grades indicated.

4.4.2.6 Typical Section for Airfields, Roadways & Parking Areas

a. Roadways: Provide preliminary typical sections for each different roadway width. Indicate lane widths, shoulder widths, and cross-slopes.

b. Parking Areas: Provide preliminary typical section for various parking areas.

c. Airfields: Provide preliminary typical sections for runways, taxiways, and aprons.

4.5. PRELIMINARY DESIGN (50-60%)

Advance from concepts into design. Comply with comments from the concept review.

4.5.1. Preliminary Design Analysis

Update and expand the Concept Design Analysis to support the submittal and include the following, as applicable:

4.5.1.1. Storm Drainage Design

a. Complete storm drainage design-calculations consistent with the requirements of the applicable TMs and based on the design values established in the Concept Design Analysis.

b. Provide a map outlining drainage areas affecting new construction.

c. Use the General Instructions Relative for the Design of Storm Drainage Systems for Other Than Airfields based on TM 5-820-4. See paragraph 4.8 below.

d. Provide complete calculations for sizing retention and/or detention ponds. Provide calculations verifying compliance with all State regulations. Coordinate calculations with applicable State Regulatory Agencies. Provide documentation of coordination meetings.

e. Provide watertight joints for drainage pipe under all pavements (aircraft and vehicular) when the pipe is placed in a noncohesive soil (see TM 5-820-4, paragraph 2-06j). Provide soil tight joints at all other locations.

g. Contour intervals should be 1 foot (25cm), unless otherwise directed.

4.5.1.2. Pavement Design

a. Complete flexible and rigid pavement design calculations consistent with the requirements of the applicable TM's and based on the various design values in the Concept Design Analysis.

b. Present complete calculations for pavement options to be allowed.

c. Provide materials to be used in pavement structure and their thickness.

d. Provide the minimum compaction requirements.

4.5.1.3. Additional Information

List additional information or criteria needed for final design.

4.5.2. Preliminary Drawings

Although it is intended that major items of work be shown separately, different items may be shown on the same sheet provided that the presentation is sufficiently clear to permit legible reproduction at half-scale.

4.5.2.1. Location and Vicinity Maps

Update for 35% as required.

4.5.2.2. Removal and/or Relocation Plan

a. Indicate all items of site work, which shall require removal or relocation.

b. Provide dimensioning for removal items such as pavements, curbs, sidewalks, etc.

4.5.2.3. Geometric Layout Plan

a. Complete the geometric layout of all items of new work using offset dimensions from existing structures or, use coordinates for locating new work.

b. Include in the plan information on specific items of work.

c. Provide locations of soil boring locations and designations.

d. Complete the legend to include all items and symbols shown on the plans. Symbols should be consistent between successive drawings.

e. Show on the plan the construction centerline, right-of-way limits, and all-important topographical features such as fences, buildings, streams, railroads, etc.

f. Locate or make reference to monuments and benchmarks for horizontal and vertical control.

g. Provide complete survey information necessary for establishment of the survey centerline, new structures, building column lines, runway centerlines, etc, including coordinates or computed bearings, radii, curve data, superelevation requirements, point of intersection of centerlines, etc.

h. When superelevation is required, include in the plan a diagrammatic profile of how the superelevation is obtained and also tables of shoulder slopes versus cross slopes for the superelevated section.

i. Note on the plans the size and type of all existing structures and the manner in which they are to be utilized or removed, or otherwise affected by new work.

j. If widening of the pavement is required in curves provide sufficient details to facilitate the construction.

4.5.2.4. Grading and Drainage Plan

a. Indicate all items of work superimposed on the existing topography.

b. Indicate the proposed contours for new grading and provide spot elevations as required to facilitate field layout. All contour intervals should be 1 foot (25cm), unless otherwise directed .

c. Layout the new storm drainage system using the symbols covered in the legend.

d. Identify drainage structures with number designations corresponding to those used in the storm drainage schedule to be included in the drawings.

e. Indicate the finished floor elevations of new buildings.

f. Locate or make reference to monuments and benchmarks for horizontal and vertical control.

4.5.2.5. Storm drain profiles

a. Provide profiles for all storm drains and roadway culverts. Indicate invert elevations of all drainage structures, storm drainpipe with size and invert elevations, ground profile, and new or existing structures or utilities crossing the new storm drain.

4.5.2.6. Profile Sheets for Airfields, Roads, and Parking Areas

a. Provide the centerline profile. Unless otherwise directed, use a vertical scale of 1” = 5’ (1:50) or as appropriate to terrain. Indicate and label beginning and ending tie points.

b. Provide elevations at points where changes of grade occur.

c. Indicate the lengths of vertical curves.

d. Indicate the existing ground line at centerline on the profile.

e. Indicate the percentage of slope for all grade lines. Provide special information pertaining to the profile and affecting the design such as curb grades, gutter grades, drainage structure inverts and top elevations, etc.

f. Provide centerline grade elevations at each 50-foot (15M) Station.

g. Show new and existing drainage structures on the profile.

4.5.2.7. Miscellaneous Details

Plans shall include the following,

a. Minimum paving and compaction requirements.

b. Typical sections through the building site as required for clarity.

c. Legend.

d. Storm drainage pipe and structure schedule.

e. Parking layout.

f. Superelevation and widening details.

4.5.2.8. Concrete Joint Plans

a. Concrete Joint Layout Plans. Provide a joint layout plan for each concrete apron, hardstands, road, pavement, etc. Joint plan shall clearly indicate the required joint type for all joints as well as slabs which require reinforcement. The scale of layout plans shall be 1”=20 (1:200m) unless otherwise approved.

b. Concrete Joint Grading Plans. Provide a joint grading plan for all concrete pavements, aprons, hardstands, roads, etc. Grade for each joint intersection shall be provided on the plan at the specific joint. Only joints with grades, which can be linearly interpolated, may be omitted. Sufficient grades must be provided to facilitate calculation of all joints in the plan.

c. Concrete joint details. Provide details of all joint types as applicable to the project. Provide detail of joint sealant.

d. Sidewalk joint layout. Provide details of sidewalk joints for entrances at buildings, handicap ramps, and circular drives, etc, as applicable.

4.5.2.9. Erosion and Sediment Control Plan (BMP Plan)

a. For all projects with land disturbance provide a sediment and erosion control plan. Plan shall design the necessary “best management practices” required to control sedimentation and erosion throughout the life of the construction project.

b. Provide calculations in the design analysis for sizing sedimentation basins, ditches, ditch liners, etc.

c. Provide details as required for all erosion and sediment control devises.

d. Provide erosion and sediment control phasing notes.

4.6. FINAL DESIGN (UNREVIEWED 100%)

Advance design to completion complying with comments from the Preliminary Review.

4.6.1. Final Design Analysis

Update previously prepared analysis to support final plans and specifications.

4.6.1.1. NPDES Construction Permit Application

a. Provide a completed application for the District Engineer’s signature, for applicable projects requiring NPDES Permitting.

b. Provide Best Management Plan certification for State projects requiring certification of the Best Management Plans.

4.6.2. Final Drawings

a. Add general notes to drawings as required.

b. Insure correct cross-referencing among site drawings for appropriate details, sections, match lines, etc.

c. Eliminate all conflicts (horizontal and vertical) among site plans and architectural, structural, and utilities plans.

4.6.3. Final Specifications

a. Complete draft of specifications to cover all items of site work.

b. Insure consistency of terminology between plans and specifications for notations on specific items of work.

c. Perform check to insure adequate referencing for construction details.

4.7. CORRECTED FINAL SUBMITTAL REQUIREMENTS (l00%)

4.7.1. Final Design Analysis

Complete analysis supporting the requirements of the project.

4.7.2. Final Design Drawing

Complete thoroughly checked drawings and specifications, with all comments from the final review incorporated.

4.8. GENERAL INSTRUCTIONS RELATIVE TO DESIGN OF STORM DRAINAGE SYSTEMS FOR OTHER THAN AIRFIELDS

4.8.1. References

a. TM 5-820-4, Drainage for Areas Other Than Airfields.

b. Design compilation sheets (4 total).

c. Sample "Storm Drainage Pipe and Structure Schedule" (To be included on the Plans as appropriate).

4.8.2. General

For the design of other than airfield storm drainage systems, the procedure that follows and, as appropriate, TM 5-820-4 shall be utilized. Design compilation sheets, reference l.c., shall be used during the design and included as a part of the design analysis. The design analysis shall also include an overall drainage map depicting individual drainage areas, assumed paths, and slopes of runoff used to compute times of concentration, and the types of surface within the individual areas.

For projects located in the states that require storm water permits, the designer shall perform the drainage design in accordance with the state's criteria. The designer shall maintain a complete record of the criteria and calculations.

4.8.3. Notes To Designer

a. The "Procedure for Design of Storm Drainage Systems for Other Than Airfields" was developed to consolidate and clarify design criteria and procedures presented in TM 5-820-1 and TM 5-820-4, to facilitate designs of other than airfield drainage systems, and to achieve design consistency.

b. This design procedure in no way relieves designers of their responsibility to comply with the provisions and requirements of TM 5-820-4.

c. The storm runoff design procedure presented in Steps l through l2 in 4.8.5 applies to both the closed storm drainage system and individual culverts. The pipe sizing procedure presented in Steps l3 through l9 applies to closed storm drainage systems only. Individual culverts shall be sized using procedures contained in TM 5-820-4.

4.8.4. Drainage Design Criteria

a. The criteria and procedures are for areas up to one square mile, where only peak discharges are required for design, and ponding is not permitted.

b. The design storm shall be based on l0-year storm frequency with “no ponding”. The designer will check the 100-year event through the proposed system to insure no flooding or damage occurs.

c. Minimum times of concentration, t_c, of l0 minutes for paved areas and 20 minutes for grassed areas shall be used.

d. Manholes or junction boxes shall be provided at points of change in conduit grade or size, at junctions with laterals or branches, and wherever entry for maintenance is required. Distance between points of entry shall be not more than about 300 feet for conduits with diameter smaller than 30 inches. Conduit alignment between entry points shall be straight, except for 30 inches and larger sizes.

e. Pipe discharge velocities must not be less than 2.5 fps to provide for adequate pipe cleansing.

f. Minimum pipe sizes shall be l2 inches for closed drainage systems and l8 inches for individual culverts, unless unusual or special design considerations warrant using smaller pipe.

g. Storm drainage systems shall be constructed in accordance with specifications Section CE 02720. The specifications contain instructions and information that must be considered during design.

h. Metal pipes will receive paved inverts when pipe velocities exceed 6 fps.

i. Plain Galvanized Steel pipes shall receive bituminous coating.

j. Aluminized Steel, Type 2, will not require bituminous coating.

k. Plastic pipes shall be HDPE Double wall.

4.8.5. <u>Procedure For Design Of Storm Drainage Systems For Other Airfields</u>

<u>Step 1</u> - Columns l through l4 of Table "A" of Exh. 4-1 shows data necessary for drain inlet design. The drainage area for each inlet is calculated with respect to the paved, bare soil and turfed surface conditions within the area. These areas are entered in Columns 2, 3, and 4. The total drainage area for each inlet is then entered in Column 5. Surface runoff coefficients "C" are assigned from Figure II of Exh. 4-3 based on the predominant paved, bare soil, and turfed surface conditions encountered in the overall drainage area and are entered at the top of Columns 2, 3, and 4. Only under unusual circumstances shall bare surface areas be considered in the drainage calculations. The weighted coefficient "C" for inlet number 1 is calculated as follows:

$$\frac{{}^{A}\text{Paved}\ ({}^{C}\text{Paved}) + {}^{A}\text{Turf}\ ({}^{C}\text{Turf})}{{}^{A}\text{Total}} = \frac{0.06\ (0.90) + 1.83\ (0.40)}{1.89} = \underline{0.42}$$

Step 2 - The actual length of runoff "L" for each inlet or design is scaled from contour maps, etc., with respect to the paved, bare soil and turfed surface conditions encountered. The sum of the individual lengths involved is entered in Column 7. Considerations must be given to the type of flow (sheet, channelized, ditch, swale, etc.), slopes, (along the flow path), and surface retardence coefficients when selecting the runoff length. Sheet flow is assumed to become channelized flow on unpaved surfaces after a sheet flow distance of 200 feet. The selected length of runoff should represent a realistic path of flow measured perpendicular to contours and one that shall provide the maximum runoff flow time (time of concentration). The actual runoff length "L" for inlet 1 drainage area was determined to be 260 feet. The first 200 feet occurred with sheet flow on an average grass surface sloping at 0.70%. The next 35' occurred with channelized flow on an average grass surface sloping at 0.70%. The assumed surface retardence "n" was 0.40 for sheet flow and 0.20 for channelized flow. The remaining 25 feet of runoff occurred an asphalt paved surface sloping at 0.50% and having a retardence "n" of 0.02. Retardence "n" is the term used to designate the resistances to sheet, channelized, and ditch flow caused by various surface conditions such as vegetation, surface and alignment in the path of flow. Retardence coefficients are assigned from Figure III of Exh. 4-3. The average retardence "n" for inlet number 1 is calculated as follows:

$$\frac{{}^{L}\text{Surface 1 } ({}^{n}\text{Surface 1}) + {}^{L}\text{Surface 2 } ({}^{n}\text{Surface 2})}{{}^{L}\text{Total}} = \frac{200\ (0.4)+35(0.20)+25}{260}$$

Enter in Column 8.

The average slope "S" for inlet number l is calculated as follows:

$$\frac{{}^{L}\text{Surface l } ({}^{S}\text{Surface l}) + {}^{L}\text{Surface 2 } ({}^{S}\text{Surface 2})}{{}^{L}\text{Total}} = \frac{235\ (0.7) + 25\ (0.5)}{260} =$$

Enter in Column 9.

Equivalent length "L_E" is now calculated using Formula I:

L_E = 2.5 Ln/ s

Where L_E = equivalent length in feet for n = 0.4 and 5 = l%

L = actual measured distance of flow path in feet

n = average retardence coefficient

S = average slope in percent of flow path

For inlet number l, L_E is calculated as follows:

$$L_E = \frac{2.5\ (260)\ (0.34)}{0.68} = 268'$$

Enter in Column l0

Step 3 - The time required for surface runoff to reach an inlet or design point when traveling along the previously determined flow path is the time of concentration "tc." The time of concentration for each inlet or design point is obtained from Figure V of Exh. 4-4 using equivalent lengths of runoff "LE" from Column 10. The time concentration for inlet number 1 was determined from Figure V to be 22.1 minutes using the equivalent length of runoff "LE" value of 268 feet. The 22.1 figure is rounded to 22 minutes and entered in Column 11.

Step 4 - Select a design storm index from Figure I of Exh. 4-2, based upon the location of the project, and enter at the top of Table A of Exh. 4-1. For this example, the project is located in Columbus, Mississippi, which yields a design storm index of 2.6 in./hr.

Step 5 - Using Figure VI of Exh. 4-5 for inlet number 1, enter the chart from the left using tc" = 22 min. from Column 11 and read rainfall intensity under design storm index 2.6 as 4.60 in./hr. Enter in Column 12.

Step 6 - Infiltration "F" is the term used to refer to the absorption of rainfall by the ground during a design storm following a rainfall of one hour. Infiltration rates are assigned from Figure IV of Exh. 4-5 according to the predominant type of soil and ground cover encountered in the overall drainage area, and are shown at the tops of Columns 2, 3, 8, and 4. The weighted infiltration "F" for inlet number 1 is calculated as follows:

$$\frac{0.06\ (0.0) + 1.83\ (0.5)}{1.89} = 0.48\text{, enter in Column 13.}$$

<u>Step 7</u> - The Rational Method for computing runoff is Q = CA(i-F) where,

Q = runoff in cubic feet/sec
C = surface runoff coefficient
A = area (acres)
i = intensity (in./hr.)
F = infiltration rate (in./hr.)

The runoff for inlet number l is calculated as follows:

Q = 0.42 (l.89) (4.60 - 0.48) = 3.3 cfs.

Enter 3.3 cfs in Column l4. It is essential at this point to check the capacity of inlet No. l. All inlets, etc., must be sized to accommodate the design storm runoff without ponding.

<u>Step 8</u> - Columns 15 through 28 of Table "B" Exh. 4-1 show data necessary to calculate rate of inflow into drains. Enter in Column 17 distance between inlets. Enter in Column 18 the areas calculated and shown in Column 5 of Table "A.” Accumulate areas as each contributes to the entire system and enter in Column 19. The weighted runoff coefficient "C" for drain 2-3 is calculated as follows:

$$\frac{1.89\ (0.42) + 1.72\ (0.57)}{3.61} = 4.49$$

Enter in Column 20.

The weighted runoff coefficient for drain 5-6 is calculated as follows:

$$\frac{5.33\ (0.46) + 2.07\ (0.40) + 1.21\ (0.60)}{8.61} = 0.47$$

Enter in Column 20.

<u>Step 9</u> - As runoff accumulates and increases in its passage through the system, the increase in runoff is not the summation of the peak runoff of each individual area, but is an increase modified by various factors. The major factor is the decreasing intensity of the storm effect on the lower areas due to the increasing time of concentration. To attain the maximum rate of runoff at a given point, the storm must continue long enough to produce the maximum rate of inflow into each upstream drain inlet and

to permit the inflow to travel through the drain from the "critical inlet" to the given point.

The "critical inlet" is the inlet whose drainage area requires the longest time of concentration within the pipe system being considered. The "critical inlet" and its time of concentration "t_c" are determined from Column 11 of Table "A" and entered respectively in Columns 21. and 22. Pipe flow time from the "critical inlet" to the given point is referred to as "drain time" "t_d." Drain time is computed using an assumed average pipe velocity of 6 f.p.s. and entered in Column 23 for individual pipe runs. The drain time, "t_d," from the "critical inlet" to the given point is accumulated in Column 24. The critical time of concentration, "t_c," for the individual pipe run design, is calculated by adding "t_c" for the critical inlet from Column 22 to the accumulated drain time "t_d" from Column 24. The sum of the two, rounded to the nearest minute, is entered in Column 25.

Step 10 - With the time of concentration calculated in Column 25, storm intensity "i" for the drains can be derived as in Step 5, above, and entered in Column 26.

Step 11 - The weighted infiltration rate "F" for drain 2-3 is calculated as follows:

$\underline{1.89\ (0.48) + 1.72\ (0.33)} = 0.41$

Enter in Column 27.

Step 12 - The rate of inflow into the drains is calculated as in Step 7 above and entered in columns 28 and 32.

Step 13 - Columns 29 through 42 show data necessary for the design of storm drains. Pipe sizes, gradients, and velocities are determined on the basis of flowing full using Manning's equation ($Q = \underline{1.49} \times R^{2/3} \times S^{1/2} \times A$). All projects shall include designs for smooth interior and fully-paved c.m. pipe ("n" = 0.024). Nomographs shown in Figures VII may be used for the design of circular pipe having respective "n" values of 0.012 and 0.024. On occasion when non-circular pipe and/or pipe having other "n" values are required, they shall be designed using the Manning's Equation. Hydraulic Design Series No. 3 of "Design Charts for Open-Channel Flow" published by the U. S. Department of Transportation, Federal Highway Administration (Reprinted 1979) is an acceptable design aid that may be used to design for these special conditions. Pipe roughness coefficients "n" for various pipe are shown in Figure X of Exh. 4.7.

Step 14 - The pipe roughness coefficient "n" is entered in the appropriate space of the top of Table "C" of Exh. 4-1. For this example, an "n" value of 0.012 is being used.

Step 15 - Enter Figure VII of Exh. 4-5 using the design discharge from Column 32. Select a pipe size such that a line drawn from the design discharge from Column 32 through the selected pipe size intersects the slope and velocity lines at minimum values. Slopes for the required pipe size should be held to a minimum consistent with limitations imposed by cover requirements, proximity to other structures, and interference with other utilities. Also, pipe sizes and slopes should be selected such that flow velocities in successive pipes remain fairly constant. To avoid ponding at intake points (inlet, catch basins, etc.), pipe inverts and velocities must be established such to maintain the kinetic energy line (velocity head $\frac{V^2}{2g}$ plus the entrance loss, head $\left(K \frac{V^2}{2g}\right)$ at or below the top or gutter line elevation of the intake structures. In most cases, providing minimum pipe cover shall fulfill or exceed the velocity head plus entrance loss requirement. Both conditions, however, must be checked to ensure that ponding shall not occur.

In profile proceeding downstream, the crowns of pipes where sizes progressively increase shall be matched. Crowns of incoming laterals shall be matched to that of mainline. Additional lowering of an outgoing pipe shall be required to compensate for head loss within the junction structure.

Step 16 - For pipe 1-2, a Q of 3.3 cfs (from Column 32) is entered into Figure VII of Exh. 4-5. At a slope of 0.85%, a 12" pipe shall handle the design discharge with a reasonable velocity. A line drawn through the pipe size of 12" and a slope of 0.85%, intersects the discharge line at 3.5 cfs and the velocity line at 4.6 fps. This indicates the capacity of the pipe flowing full is 3.5 cfs at a velocity of 4.6 fps. Enter the selected pipe size and slope into Columns 33 and 34, respectively. It is now necessary to determine the Velocity in the pipe for the design Q of 3.3 cfs. Compute the ratio of the design discharge (3.3 cfs) to the flowing full discharge (3.5 cfs) as follows:

$$\frac{Q\ \text{Design}}{Q\ \text{Full}} = \frac{3.3}{3.5} = 0.94$$

Enter the bottom of Figure IX of Exh. 4-6 at 0.94 and project a vertical line intersecting the "Capacity" curve. Continue the line horizontally from this point intersecting the "Velocity" curve. The partial full to full flow velocity ratio (^{V}Design/^{V}Full) is interpreted as 1.135 by projecting a vertical line from the "Velocity" curve to the bottom of Figure IX of Exh.4-6. The partial full or Pipe 1-2 design velocity (^{V}Design) is found to be (4.6) (1.135) = 5.2 fps and is entered into Column 35.

Step 17 - Head losses at junction structures shall now be taken into account. A loss coefficient "K" shall be selected from Figure

XI of Exh. 4-7, depending on the type of junction. The "K" which produces the largest head loss at the junction shall be selected. For pipe l-2 passing through inlet number 2, a "K" value of 0.20 is selected from Figure XI. The head loss is calculated as follows:

$$H_L = \frac{K\ V^2}{2\ g} = \frac{0.20(5.2^2)}{2(32.2)} = 0.08'$$

and is entered in Column 37.

This value is the amount of lowering required below the entrance invert of pipe l-2 for pipe 2-3 as it exits inlet number 2 to compensate for head loss through inlet. This lowering is in addition to any lowering required due to change in pipe size.

Step 18 - For each junction structure, the finished grade at the structure shall be determined and entered in Column 40. The upper and lower inverts of each pipe are then calculated and entered in Columns 38 and 39, respectively. Actual depths of cover are calculated for each pipe and entered in either Column 41 or 42, whichever is applicable. Inverts shall be set so as to maintain the cover requirements specified in Tables II-1 through II-9 of TM 5-820-4 for pipe located under traffic areas and/or high fills. The minimum cover for reinforced concrete Class III or corrugated metal pipe is l.0 foot for Civil Works Recreation and Public Use projects. In non-traffic areas, l.0 foot minimum cover is required.

Step 19 - Maximum permissible outfall velocities for non-erosive flow are given in Table 9-l of TM 5-820-3. Pipe 5-6 outfalls into an existing silty-clay bare soil ditch, which permits a maximum non-erodable velocity of 3.5 fps (from Table 9-l). The discharge velocity in pipe 5-6 is 6.4 fps; therefore, energy dissipation, erosion protection and/or discharge velocity reduction (increase pipe size and/or reduce pipe slope) is required to prevent erosion of the outfall ditch. A good design shall require analysis of several feasible alternatives to determine the most economical method of controlling erosion.

4.8.6 Bibliography

a. Figure I adopted from TM 5-820-1, Figure 1, dated April l977.

b. Figures II, III, and IV from U.S. Army Engineer School - Engineer Subcourse 359-3, Edition 3 (July l973), Tables 2-2, 2-1, and 2A-2 respectively.

c. Figure V derived from average values taken from Figures 10 through l7, TM 5-820-1, dated April l977.

d. Figure VI derived from Figure 2, TM 5-820-l, dated April l977.

e. Formula I from U.S. Army Engineer School - Engineer Subcourse 359-3, Edition 3 (July l973), page 2 A-15.

f. Figures VII and VIII were taken from TM 5-820-l, Figures 25 and 27, respectively, dated April l977.

g. Figures IX was taken from TM 5-820-4, Figure l0, dated July l965.

h. Figure X was taken from TM 5-820-3, Table 2-1, dated Jan. 1978.

i. Figure XI was derived from "Handbook of Hydraulics," fifth edition by King and Brater.

CHAPTER 5

SURVEYING AND MAPPING

INDEX

CHAPTER 5

SURVEYING AND MAPPING

5.1 GENERAL

This chapter presents general requirements for surveying and mapping, as well as the processing of the data that may be required for the work necessary in the design and advance planning of the project. All labor, materials, and equipment necessary to perform site surveying and mapping services is required. Adequate professional supervision and quality control must be provided to assure the accuracy, quality, completeness of the site surveys.

5.2 APPLICABLE PUBLICATIONS

The following publications may be applicable for site surveying and mapping for the design of the project.

5.2.1 Standards Manual for U. S. Army Corps of Engineers

EM 1110-1-1003	NAVSTAR Global Positioning System Manual, dated Sept.1990.
EM 1110-1-1000	Photogrammetry Manual.
EM 1110-1-1001	Geodetic Control.
EM 1110-1-1005	Topographic and Field Surveying and Mapping.
EM 1110-2-1003	Hydrographic Surveying, dated August 1990.

5.2.2 Technical Manual for U. S. Army Corps of Engineers

TEC-1110-1-147	CORPSCON.

The Engineering Manuals (EMs) listed above shall take precedence over District Manuals.

5.3 PROJECT DEFINITION

5.3.1 General Statement of Surveying and Mapping Services

The designer shall submit a general statement (scope of work) as to what type surveying and mapping services shall be required for the site plan (if applicable). The following information is required:

a. Name and location of the project.

b. Type of surveying and/or mapping services (geodetic, topographic, hydrographic, route location surveys, etc.).

c. English or metric surveys.

d. Site map to scale showing area to be surveyed (acres, length of route location survey, etc.). Scale required for the new survey (1"=30', 1"=50', 1"=100', 1"=200', etc.) and contour interval (1', 2', 5', etc.).

e. General description of utilities (above and/or underground) that shall be located (if applicable).

5.3.2 Existing Horizontal and Vertical Site Control

The Government shall upon request, furnish all pertinent horizontal and vertical control data on file. The following information is required when making a request.

a. Location and name of the project.

b. General site map of the project area showing location and coordinate values (NAD27 or NAD83).

Existing site control (horizontal and vertical) shall be requested from the Corps of Engineers at the following address:

U. S. Army Engineer District, Jacksonville
Attention: CESAJ-EN-DT
Post Office Box 4970
Jacksonville, Florida 32232-4970

5.4 CONCEPT OF SURVEYING AND MAPPING SERVICES

The following surveying and mapping services may be necessary in the design and advance planning of the project:

5.4.1 Geodetic and Control Surveys

Includes surveys in which the figure and size of the earth are considered and is used for precise location of basic points suitable for controlling other surveys. Includes 1st, 2nd, and 3rd order horizontal and vertical control surveys, geodetic astronomy, gravity, and magnetic surveys in accordance with the Standards and Specifications for Geodetic Control Networks published by the Federal Geodetic Control Committee dated September 1984. Conventional, electronic instrumentation, inertial, satellite and other survey methods, as applicable, may be utilized.

5.4.2 Topographic Engineering and Construction Surveys

Includes acquisition of topographic surveying and mapping data representing three-dimensional spatial relationships on the earth's surface.

This data may be required for planning, cost estimating, engineering, design, construction, master planning, operations, and recording as-built conditions. Conventional and electronic instrumentation, remote sensing, inertial, satellite and other survey methods, as applicable, may be utilized.

5.4.3 Topographic

To be accomplished either by plane table and/or Total Station with Data Collector.

5.4.4 Route Location Surveys

Roads, railroads, levees, channels, etc.

5.4.5 Quantity Surveys

Preconstruction and/or final cross-sections and computations of quantities.

5.4.6 Layout Surveys

Staking of buildings, structures, utilities, roads, railroads, etc.

5.4.7 Hydrographic Engineering and Construction Surveying

Surveys of channels, lakes, rivers, bays and open coastal waters in support of engineering design, construction, and operations and maintenance. Includes acquisition of hydrographic and surveying and mapping data representing three-dimensional spatial relationships on the earth's surface. This data may be required for planning, cost estimating, engineering, dredging, design, construction, sedimentation, master planning, operations and as-built conditions period, conventional and electronic instrumentation, and remote sensing, inertial, satellite, side scan sonar, subbottom profiling, marine magnetometer, and other surveying methods, as applicable, may be used.

5.4.8 Precise Surveys

First, second, or third order horizontal and vertical surveys to monitor movement of structures or precise location of structures.

5.4.9 Boundary and Cadastral Surveying

Includes property, boundary and easement surveys, etc. Conventional, electronic instrumentation, inertial, satellite, and other survey methods, as applicable, may be utilized.

5.4.10 Photogrammetric Services

Includes acquisition of surveying and mapping data from measurement of photographs representing either three dimensional or planimetric spatial relationships on the earth's surface. Stereo plotting, bridging, photographic laboratory, and reproduction services, acquisition of aerial photography, drafting, and scribing. Photogrammetric mapping to include film negatives, film and glass positives, photo indexes, photo enlargements, computations, scribecoats, compilation histories, and mapping on stable base materials may be required.

5.4.11 Supplemental Map Control (SMC)

Establishment of third order horizontal and vertical control on photo identifiable points for Photogrammetric mapping.

5.4.12 Cartographic Surveying

Includes acquisition and assimilation of topographic and/or hydrographic surveying and mapping data for preparation of maps, charts, and similar products for planning. Conventional and electronic instrumentation, inertial, satellite and other survey methods, as applicable, may be utilized.

5.4.13 Mapping and Charting

Includes the preparation (i.e., design, compilation , digitizing, scribing, drafting, and printing) of map and chart products. These depict man-made and natural features of a part to the surface of the earth in their correct positions and at an established scale relative to a coordinate reference system. These maybe associated with engineering, land/boundary, geodetic and/or cartographic surveys. Conventional, electronic, or computer-assisted design & CADD systems as applicable may be utilized.

5.4.14 Digital Data

Survey data is required in Intergraph IGDS 3D design files and DTM files compatible with Intergraph InRoads (version 7.1). All digital survey data shall be in accordance with Tri-Service A/E/C CADD Standards (http://tsc.wes.army.mil/intro.asp). The AE Designer shall store and maintain a copy of all electronically created digital files (CD's, and Disc, etc.) through the construction phase of the project. These files shall be made available to the government upon request and shall be maintained with no additional cost to the Government.

5.5 MINIMUM TECHNICAL STANDARDS FOR SURVEYING AND MAPPING SERVICES

5.5.1 Registered Land Surveyor

All surveying and mapping services shall be accomplished under the direction/supervision of a Registered Land Surveyor in the State in which the project is located. Site plan mapping shall be signed and sealed with the following statement: "I HEREBY STATE THAT THIS SURVEY AND DRAWING(S) MEETS OR EXCEEDS THE MINIMUM TECHNICAL STANDARDS FOR THE PRACTICE OF LAND SURVEYING IN ALABAMA, FLORIDA, GEORGIA, MISSISSIPPI OR TENNESSEE".

5.5.2 Horizontal and Vertical Datum

All site plan surveying and mapping shall be referenced (tied) to the Local State Plane Coordinate System (NAD27 or NAD83) and the National Geodetic Vertical Datum (NGVD29) with no less than third (3rd) order accuracy and procedure. Assumed coordinates and vertical positions can be used only with the Government's permission. Design drawing(s) shall indicated what horizontal and vertical control datum was used for the site surveys.

5.5.3 Survey Monuments

A minimum of three permanent survey monuments shall be established on or adjacent to the design site. Survey monuments must be established in areas that shall not be disturbed prior to and during the construction phase of the project. Designation and date established shall be stamped on each survey monument. No less than third order horizontal and vertical control shall be established on each survey monument. A detailed description with horizontal and vertical datum shall be indicated on the site plan survey and design drawings. The following are requirements for a survey monument:

a. Be composed of a durable ferrous or magnetic material with minimal length of eighteen inches and cross-section area of material of 0.3 square inches.

b. Be identified with durable marker or cap bearing designation, date and Registration Number of the land surveyor in responsible charge.

c. Be detectable with conventional instruments for finding ferrous or magnetic objects.

5.5.4 Site Plan drawing(s)

All permanent survey monuments established on site shall be shown on the final design drawings. Inserts on the drawings and/or digital files shall show a detailed sketch of the location with description of the permanent monuments established on site. Course chart on the drawings shall show coordinate and vertical values of each permanent monument.
The following is an example of a course chart:

NAME OF PROJECT AND LOCATION

DESIGNATION OF POINT	TYPE MARK DATE	NORTHING NAD27	EASTING NAD27	ELEVATION NGVD29
21A-3B	CONC. MON, 1994	345,123.34 (ME)	1,234,456.00(ME)	234.56 FT.
21A-3C	REBAR	345,140.66	1,234,400.56	246.98 FT.
BB-3	REBAR	345,340.45	1,234,645.14	76.33 M
21A-3D	CONC. MON 1994	345,450.98	1,234,823.34	77.45 M
212-3	3/4" IRON ROD	345,003.45	1,234,700.98	224.21 FT.
		NAD83	NAD83	223.78 FT.
212-4	3" PVC PIPE (WE)	256,234.67(AW)	1,989,067.00(AW)	225.90 FT.

5.5.5 Compliance with Applicable Laws

All personnel shall strictly observe the laws of the United States or other governing body affecting operations at all sites. The personnel shall comply with all applicable laws under which they are operating including those concerning the inspection and operation of equipment and the licensing of Engineers, Land Surveyors, pilots, mechanics and other personnel. It is further understood and agreed that the Designer assumes full responsibility for the safety of his employees, plant, and materials.

5.5.6 Security Clearance

If so indicated in the Statement of Work, personnel working on the project shall be capable of obtaining a temporary security clearance. The following information is required: Full Name, Position, Social Security Number, Date of Birth, Place of Birth, Security Clearance, Citizenship, Drivers License Number and State of Drivers License. Include with this list the name and phone number of a point of contact in case of an emergency. It is the responsibility of the designer to assure all personnel used can obtain the clearance.

5.6 DESIGNER'S RESPONSIBILITY FOR UNSATISFACTORY SITE SURVEYS

If the site surveying and mapping services are found to be in error prior to and through the construction phase of the project, the designer shall be responsible for all cost in connection with correcting such errors. The designer shall be and remain responsible to the Government in accordance with applicable law for all damages to the Government caused by negligent performance of any services.

CHAPTER 6

GEOTECHNICAL

INDEX

CHAPTER 6

GEOTECHNICAL

6.l GENERAL.

This chapter outlines the content of the Foundation Report to be provided to all designers for use in design and incorporated in the various submittal stages. The Mobile District(MDO), or a contractor hired by MDO or the designer shall provide to the designer a comprehensive Foundation Report as soon as it can be formulated after notice to proceed. If the designer arranges the geotechnical investigation, the designer, or his consultant, shall be required to plan and conduct a geotechnical investigation of the proposed site based on the Statement of Work (SOW). The report shall present the results of the subsurface investigation and laboratory testing and shall offer recommendations for the design of structure foundations, pavements, and other geotechnical features. Logs of borings shall be provided as an appendices to the Foundation Report, design analysis, and contract specifications using ENG Form 1836 and ENG Form 1836a for continuation pages unless otherwise approved. Specifications for all earthwork operations and specialty items such as dewatering systems, piling operations, slope stabilization, etc., shall be provided. Specialty field tests such as ph measurements, resistivity tests, and percolation tests shall be included for use in design, if appropriate. The designer shall be responsible for selecting the structure foundation type based on the recommendations offered in the Foundation Report. The designer shall be responsible for insuring that the Foundation Report contains all the required data to design the foundation, to include items such as construction and permanent dewatering, pile driving, slope stabilization, etc. It shall be the designer’s responsibility to insure that the geotechnical investigation adequately characterizes the site geology and hydrogeology and that all data required to complete the project design is collected and analyzed. This chapter also lists the specific requirements of the submittal stages for geotechnical design features. The Foundation Report including logs of borings and laboratory test data shall be made a part of the Design Analysis and shall be reviewed by MDO if the Foundation Report was not prepared by MDO. The Foundation Report may be submitted for review prior to the conventional submittal dates if time permits. The designer should contact the Geotechnical and Dam Safety Section if there are any questions about the content of the Foundation Report or the features required by the various submittal stages or if the project has been resited.

6.2 APPLICABLE PUBLICATIONS.

6.2.1 ASTM Specifications.

Many of the "Guide Specifications" reference ASTM specifications. Most of the ASTM specifications that are usually referenced by geotechnical specifications can be found in volume 04.08 of ASTM. Listed below are the most frequently used ASTM specifications. These specifications or their updated versions should be referenced.

C 117-90	Test Method for Material Finer Than 75 -um(n o.200) Sieve in Material Aggregates for Washing
C 136-84	Method for Sieve Analysis of Fine and Coarse Aggregates
D 420-87	Recommended Practice for Investigating and Sampling Soil and Rock for Engineering Purposes
D 421-85	Practice for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants
D 422-63	Method for Particle-Size Analysis of Soils
D 653-90a	Terminology relating to Soil, Rock and Contained Fluids
D 698-91	Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft3) (600kN-m-m/3)
D 1140-54	Test Method for Amount of Material in Soils Finer than the No. 200 (75-um) Sieve
D 1241	Specification for Materials for Soil-Aggregate Subbase, Base, and Surface Courses
D 1452-80	Practice for Soil Investigation and Sampling by Auger Borings (1990)
D 1556-90	Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
D 1557-91	Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort
D 1586-84	Method For Penetration Test and Split-Barrel Sampling of Soils
D 1587-83	Method For Thin-Walled Tube Sampling of Soils
D 2113-83	Method for Diamond Core Drilling for Site Investigation (1987)
D 2167-84	Test Method for Density and Unit Weight of Soil In-Place by the Rubber Balloon Method (1990)
D 2216-90	Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock
D 2487-90	Classification of Soils for Engineering Purposes
D 2488-90	Practice for Description and Identification of Soils (Visual-Manual Procedure)
D 2922-91	Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
D 2937-83	Test Method for Density of Soil in Place by the Drive-Cylinder.

D 3017-78 Test Method for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)

D 3740-88 Practice for Evaluation of Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design

ASTM D 4043-91 Guide for Selection of Aquifer Test Method in Determining Hydraulic Properties by Well Techniques

ASTM D 4044-91 Test Method (Field Procedure) for Instantaneous Change in Head (Slug Test) for Determining Hydraulic Properties of Aquifers.

D 4318-84 Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

D 4428/4428M-91 Test Method for Crosshole Seismic Testing

D 4718-87 Practice for the Correction of Unit Weight and Water Content for Soils Containing Oversize Particles

D 4829-88 Test Method for Expansion Index of Soils

G 57-78 Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method

G 57-78 Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method (1984)

6.2.2 <u>Government Technical Publications</u>.

AFM 88-3 Soils and Geology: Procedures for Foundation Design of Buildings and Other Structures (Chapter 7)

EM 1110-1-1-1904 Settlement Analysis

EM 1110-1-1-1905 Bearing Capacity of Soils

6.3 PROJECT DEFINITION (10-15%).

The Project Definition Submittal should have a geotechnical chapter that states the known general geology and physiology of the project site. The chapter should state the site's history and its status as a potential site of Hazardous and Toxic Waste(HTW) contamination. The chapter should further state the status of the foundation investigation and report.

6.4 CONCEPT DESIGN (30-35%).

6.4.1 Design Analysis.

(a) Incorporate recommendations stated in the Foundation Report into the design.

(b) Provide foundation design calculations using parameters outlined in the Report and include a copy of the Report in the design analysis.

(c) Notify the Geotechnical branch of any conflicts between the Foundation Report and concept design. If the topographic surveys are to be performed by the designer, then an electronic file copy in a DGN format of the survey must be sent to the entity performing the geotechnical investigation, as soon as possible but no later than the date for the submittal of the 35% design.

(d) Include boring logs and laboratory test data as an appendix.

6.4.2 Design Drawings.

(a) Locate soil borings, test pits, monitoring wells and piezometers on the civil site plan. Add the appropriate symbol to legend.

(b) Add note to civil site plan: "For logs of borings and test data, see __." and reference the appendix that includes boring logs and test data.

6.5 INTERIM DESIGN (50-60%).

Comply with the accepted comments on the concept design.

6.6 FINAL DESIGN (UNREVIEWED 100%).

6.6.1 General.

(a) Comply with comments on the interim review.

(b) Return the specifications provided by MDO along with designer prepared specifications for final review.

6.6.2 Design Analysis.

(a) Incorporate recommendations stated in the Foundation Report into the design.

(b) Provide foundation design calculations using parameters outlined in the Report, and include a copy of the Foundation Report in the design analysis.

(c) Notify the Geotechnical branch of any conflicts between Foundation Report and final design.

(d) Include boring logs and laboratory test data as an appendix of the specifications. Provide separate Adobe Acrobat Portable Document Format files named “logs.pdf” and “tests.pdf” for the appendix. Include “General Notes”, “Soil Classification Legend”, “Rock Classification Legend” if applicable, and Abbreviations pages at the beginning of the logs.pdf file, followed by boring location map if applicable, followed by the boring logs. Soil borings, test pits, monitoring wells and piezometers shall either be located in the appendix with boring logs (file logs.pdf) or located on civil site plans. Locations shall be clearly legible when printed at 8.5 in. x 11-in. size if included in logs.pdf file. Include laboratory test data in the file “tests.pdf.” Do not include the narrative portion of the Foundation Report or any sections or profiles containing interpretations of subsurface data in Appendix “A.”

6.6.3 Design Drawings.

(a) Locate soil borings, test pits, monitoring wells and piezometers on civil site plan. Add the appropriate symbol to legend.

(b) Add note to civil site plan: "For logs of borings and test data, see __“ and reference the appendix that includes boring logs and test data.

6.7 READY TO ADVERTISE (100%).

(a) Comply with comments on the final design review.

(b) Include any drawings and specifications prepared by MDO in the Index of Drawings and the Table of Contents for specifications.

(c) Include boring logs and laboratory test data as Appendix ‘A’ of the specifications. Provide separate Adobe Acrobat Portable Document Format files named logs.pdf and tests.pdf for Appendix ‘A’. Include “General Notes,” “Soil Classification Legend,” “Rock Classification Legend” if applicable, and Abbreviations pages at the beginning of the logs.pdf file, followed by the boring logs. Include laboratory test data in the file tests.pdf. Do not include the narrative portion of the Foundation Report or any sections or profiles containing interpretations of subsurface data in Appendix ‘A’.

6.8 TECHNICAL REQUIREMENTS.

6.8.1 Deep Foundations.

The Foundation Report shall provide recommendations for the type of deep foundation system to be used (piling, caissons, etc.), the size and length of the piling, the estimated tip elevation, and the allowable bearing capacity of each pile. The designer shall responsible for selecting the type of deep foundation to be used, determine the number of piles, actual spacing, and the pile cap design. If caissons are used the designer shall insure that the report addresses the caisson diameter, embeddment depth, top of sound rock, number of caissons, spacing during installation, and allowable bearing capacity. The number and location of test piles and load tests to be specified in the construction contract should be recommended. The designer shall be responsible for securing all required geotechnical data during the geotechnical investigation if so tasked.

6.8.2 Temporary Construction and Permanent Dewatering Systems.

6.8.2.1 Temporary Construction Dewatering.

Based on the results of the geotechnical investigation the designer shall be responsible for determining project-dewatering requirements. Short-term construction dewatering due to poor surface drainage, precipitation, or short duration work at or near the water table is generally considered a contractor responsibility. Using information from the Foundation Report, the designer should alert the contractor to any known conditions that shall require short term dewatering.

When temporary construction dewatering shall be required due to a consistently high water table or the effects of underlying artesian aquifers the designer shall design and present a dewatering plan in sufficient detail that the contractor can bid on and install the dewatering system. The designer shall be responsible for securing all the required information necessary for the design of the system (aquifer properties, geotechnical analyses of sediments, etc.) during the geotechnical investigation. For construction dewatering designs the use of slug tests to determine aquifer characteristics (hydraulic conductivity, transmissivity, storage coefficient, etc.) shall not be acceptable.

6.8.2.2 Permanent Dewatering Systems.

The designer shall be responsible for securing the required aquifer properties and hydrogeologic data during the geotechnical investigation. The selection of well screen slot sizes, screen lengths, discharge pipe sizes, installation methods, etc. shall be the responsibility of the designer. The use of slug tests to determine aquifer characteristics (hydraulic conductivity, transmissivity, storage coefficient, etc.) shall not be acceptable.

6.8.3 Earth Liners.

The geotechnical investigation should provide the designer with the overall geologic conditions, the in situ and constructed permeabilities that can be obtained using native materials and stabilizing agents, liner types and thickness', and slope stabilization requirements. The designer shall be required to apply for all necessary permits. As part of the permitting process he shall be required to determine the classification of the material to be contained, the permeability necessary to contain the material, and the size and functional configuration of the containment area. No earth liners shall be permitted when material to be retained has a Ph below 5.

6.8.4 Cathodic Protection and Grounding Systems.

The geotechnical investigation should include all ph tests, salinity tests, resistivity measurements, etc., required to design corrosion control and grounding systems. The raw field data shall be provided in the Foundation Report without interpretation or recommendations. The designer shall design all corrosion control and grounding systems required for the project and shall advise MDO immediately if additional field data is required.

6.8.5 Permanent Water Well Design and Construction.

If required by the SOW, the designer shall be required to determine the location of the well, verify the gpm requirements, verify future demands based on facility estimates, and determine the pump size and type. The permanent well design shall be based on data collected from the installation and aquifer testing of a pilot well. Test well borings shall be continuously sampled and visually logged by a qualified geologist. Additionally, the borehole shall geophysically logged to verify the visual log. Sediment samples from the anticipated production zone(s) shall be analyzed for grain size distribution and any other required parameters to assist in the design of the well. The completed design shall specify casing sizes and lengths, grouted intervals, well screen slot size(s), screen length, filter pack gradation, centralizer locations, and testing requirements to insure the straightness and plumbness of the borehole and completed well.

6.8.6 Structures.

The Foundation Report shall recommend the type of foundation system to be used, the allowable bearing capacity, the depth of placement and bearing elevations for the footings, and the floor slab preparation. The designer shall size all footings, grade beams, slabs, etc., utilizing the recommendations and restrictions presented in the Foundation Report. The designer shall prepare earthwork specification for the structures. See Chapter 11 titled STRUCTURAL for further design requirements.

6.8.7 Pavements.

The Foundation Report shall recommend for pavement subgrades the allowable design CBR and modulus of subgrade reaction parameters along with the required compaction effort. Guidance shall be offered on the types of base course materials available in the area and design strengths. The designer shall prepare all earthwork specifications for pavement subgrades. The designer shall prepare all pavement material specifications with consultation from the Geotechnical Branch. See Chapter 4 titled SITE DEVELOPMENT, for deviations or exceptions.

6.8.8 General Earthwork and Special Features.

The Foundation Report shall recommend undercutting requirements, fill and backfill placement procedures, types of compaction equipment to be used, and outline earthwork procedures for special features such as retaining walls, embankment construction, earth covering of structures, basements, buried and mounded tanks, utilities, etc. The designer shall prepare all earthwork specifications (Mobile District sections 02221, 02222, and 02225) for the general conditions. The Geotechnical Branch shall assist the designer in the preparation of specifications for any special features. For projects requiring gabion or riprap slope protection, the designer shall coordinate with the Geotechnical & Dam Safety Section (EN-GG) for required materials investigations and/or specification requirements. Notification of the proposed slope protection should be given EN-GG as soon as possible so as to allow time for any needed sampling and testing.

EXHIBIT 6-1

(INSERT FILE EXH6-1.DGN HERE)

EXHIBIT 6-2

(INSERT FILE EXH6-2.DGN HERE)

EXHIBIT 6-3

(INSERT FILE EXH6-3.DGN HERE)

EXHIBIT 6-4

(INSERT FILE EXH6-4.DGN HERE)

EXHIBIT 6-5

(INSERT FILE EXH6-5.DGN HERE)

EXHIBIT 6-6

(INSERT FILE EXH6-6.DGN HERE)

EXHIBIT 6-7

(INSERT FILE EXH6-7.DGN HERE)

GEOTECHNICAL REPORT CHECKLIST

1. Describe general site access with respect to mobility or drilling or other test equipment. Field sketches of existing utilities, fences, walkways and pavements should be made to compare to the topography map.

2. Generally describe the site topography and note all the topographic features that effect the project.

3. Describe the slope of the ground surface and delineate all drainage channels and any previous cut and fill or erosion.

4. Describe existing structures, pavements, or other obstructions and the procedures for demolition.

5. Fully describe the results of the subsurface investigation and any laboratory testing and its impacts on constructing the project.

6. GENERAL SCOPE:

   a. Results of fdn. investigation & testing
   b. Recommendations based on (a) above.

7. DETAIL INFORMATION:

   a. Description of structure(s)

      (1) Written general description
      (2) Type of construction contemplated.
      (3) Size and Height
      (4) Finished Floor elevation; Elevation of existing ground
      (5) Type of Foundation recommended
      (6) Approximate load (s)
      (7) Special Features affecting Foundation Design
      (a) Water Table, or history of dewatering or seepage problems
      (b) Condition or history of nearby buildings
      (c) Analyze whether dewatering would cause settlement of adjacent structures
      (d) Location of fill or dump areas near site which may jeopardize foundation
      (e) Existing buried Utilities conflict with new foundations

   b. Specific recommendations for foundation design and/or construction based on site features.

      (1) Topography
      (2) Surface Water
      (3) Groundwater
      (4) Subsurface soil conditions
      (5) Availability of borrow materials
      (6) Location & availability of spoil areas
      (7) Permitting actions required.

EXH-6-8

c. Results and/or Recommendations for:

(1) Bearing capacity
(2) Piles (Type, length, capacity, type of installations)
(3) Retaining Walls or basement walls
(4) Mat Foundations
(5) Slope Stability
(6) Settlement
(7) Permanent ground water drainage around or under structures
(8) Construction Dewatering
(9) Erosion control during and after construction

d. Revisions, additions, and/or deletions to the standard guide specs resulting form the foundation analysis.

(1) Include a copy of the specification as it is proposed to be used.
(2) Mention the major changes in the write-up and the reason for making them.

e. Design Calculations

(1) Include applicable design calculations on settlement, bearing capacity, seepage, uplift, stability analysis, quantities, shrinkage, dewatering, etc.
(2) Show formulas, assumptions and reference source

f. Site Plan

(1) Show building road locations
(2) Contours
(3) Boring, test pit, infiltrometer locations
(4) Locations of temporary & permanent surface water diversion measures
(5) Location of buried utility line (existing & to be installed)

g. Logs of all boring and test pits in Adobe Acrobat Portable Document Format in file named logs.pdf. Make sure the logs have horizontal control to the nearest foot and vertical control to the nearest tenth of a foot shown for each log.

h. Results of all laboratory test data in Adobe Acrobat Portable Document Format in file named tests.pdf.

i. Detailed Dewatering design, if it is to be a major foundation cost.

CHAPTER 7

LANDSCAPE, PLANTING AND TURFING

INDEX

CHAPTER 7

LANDSCAPE, PLANTING AND TURFING

7.1 GENERAL.

7.1.1 Scope.

Specific submittal and technical requirements for landscape planting and turfing are presented in this chapter as guidance for development of plans and specifications. The quality of planting design shall be comprehensive and shall be coordinated with pertinent aspects of the overall site development, the architecture of structures, and user requirements.

7.2 APPLICABLE PUBLICATIONS.

7.2.1 Department of the Army Technical Manuals.

TM 5-803-5	Installation Design. l Mar 81
TM 5-830-4 Jun 76	Engineering Design: Planting and Maintenance of Trees, Shrubs, Ground Covers, and Vines.

7.2.2 Corps of Engineers Guided Specifications.

02935	Turf
02950	Trees, Shrubs, Ground Covers, and Vines.

7.3 PROJECT DEFINITION (10-15%)

The project definition shall verify the minimum design requirements for the work being performed in the landscape plan. Specific boundaries, limits of the work being performed, shall be delineated to anticipate the level of development of the landscape plan. The plan will in turn be used to determine a preliminary cost estimate for the project. Specific use areas shall be located to determine the proper landscape treatment for those areas, from both the standpoint of material selection and functional use e.g. screening, canopy, color ,enclosure etc. and/or turf, it shall also be communicated in the project definition.

7.4 CONCEPT DESIGN (30-35%).

7.4.1 Concept Design Analysis.

The landscape planting design narrative shall describe the conditions of the existing site, including an indication of existing plant materials that are to remain on the site. Specific site problems related to proposed development and the rationale for proposed plant locations, shall be indicated. The narrative shall also include a list of suggested types and sizes of plant materials which are to be used, based upon the designated functional and visual criteria. The concept cost estimate shall be based on quantities derived from generalized locations and listed types and sizes of plant materials.

7.4.2 Concept Design Drawings.

The overall design approach shall depict factors which affect existing site features and influence subsequent design proposals. The concept drawings shall be prepared at a scale which corresponds with the site layout and grading plans and shall include reference coordinates, north arrows, graphic scales, and appropriate legends.

7.5 INTERM DESIGN (50-60%).

7.5.1 Interm Design Analysis.

The descriptive narrative, list of materials and cost estimate shall be refined to correspond with the development of the preliminary planting plans.

7.5.2 Interm Design Drawings.

The interm design submittal shall expand the concept design by development of an overall planting layout and shall include enlarged detail plans of specific areas, as needed, to clarify requirements. The proposed layout shall indicate shade trees, evergreen trees, flowering trees, shrub masses, etc., according to designated functional and visual locations of planting. A legend indicating sizes of plants recommended for each of the above categories shall be included. The preliminary design drawings and all subsequent plans shall indicate existing and proposed buildings, paved areas, signs, light standards, transformers, dumpster areas, storm drainage system, and other structures and utilities. If existing and proposed contours cannot be clearly indicated graphically on the plan, overlay of the drawings shall reveal that grades and elevations have been taken into account. Grassing limits, seeded or sodded, shall be clearly described in the contract documents.

7.6 FINAL REVIEW (100% UNREVIEWED).

7.6.l Specifications.

Landscape planting specifications shall be based upon the current specification Section 02950, Trees, Shrubs, Ground Covers, and Vines, edited for specific project requirements. The turf specification shall be based upon the current specification section 02935, Turf, edited for specific project requirements.

7.6.2 Final Design Drawings.

Final design drawings, indicating proposed plants by a (+) mark for the plant location and a circle which is scaled at approximately 2/3 the ultimate growth spread (diameter) of plants, shall include a complete schedule of plant materials indicating botanical and common names, plan symbols, quantities, sizes, condition furnished, and pertinent remarks. Final drawings shall also include the basic details for installation of tree, shrub, and ground cover planting, as well as any other applicable details for clarification of specific project requirements. Pertinent notes applicable to construction requirements, in addition to standard notes, shall be included. The design plan, plant schedule, details, notes, specifications, and subsequent cost estimates shall all correspond.

7.7 READY-TO-ADVERTISE (l00%).

All final design drawings, specifications, and cost estimates shall have incorporated comments from the preceding reviews before submittal as Ready-to-Advertise.

7.8 TECHNICAL REQUIREMENTS.

7.8.1 Design Criteria.

(a) Designer Qualifications. The designer shall obtain and use the services of a qualified Landscape Architect who is registered, preferably in the State in which the work is to be done, and is experienced in site planning and planting design. The person performing this work shall be thoroughly familiar with the referenced Technical Manuals, and specifications.

(b) Major Design Considerations. Design plans shall reflect user needs, simplicity of layout, proper scale and spacing of materials, low maintenance considerations, and compatibility with adjacent surrounding. Specified plant materials shall be readily available for purchase, require minimum maintenance, be suitable and tolerant to both the geographic locale and the specific site conditions, be the proper quantities selected for the surroundings, and be of sufficient size to give an immediate effect. The types and locations of plant materials shall be utilized, as appropriate to the function and prominence of specific facilities, to define the functional use areas and circulation systems of the site layout; to provide open space buffers between land uses and within parking areas; to reinforce the orientation of buildings and the use of earthforms for energy conservation; to supplement erosion control; to provide screening; and to emphasize entrances to buildings. The aesthetic quality of planting design shall be supportive in providing visual continuity in the relationships between buildings, the site, and the surrounding environment.

7.8.2 Site Investigation.

A visit to the project site is recommended as a necessary aspect of initial concept development. Visual observation of the surrounding environment of the Installation, determination, where applicable, of the continuity between new construction planning and existing development and ascertainment of the types of recommended materials and maintenance practices are influential factors in the analysis of site problems and the formulation of concept solutions.

7.8.3 Coordination.

(a) Interface with Applicable Construction Drawings. Landscape planting plans shall be coordinated with existing conditions and demolition plans, site layout, grading and drainage, utilities, architectural floor plans and elevations, and pertinent aspects of mechanical, plumbing, and electrical drawings for the locations of items such as compressors, fuel oil tanks, transformers, meters, light standards, and hose bibs.

(b) User Requirements. Coordination of Corps of Engineers and Installation requirements shall be accomplished prior to initiation of design submittals. The designer shall consult with the local user and involved Installation personnel in order to substantiate the extent of design requirements and to provide planting proposals which correspond with maintenance capabilities.

CHAPTER 8

WATER, WASTEWATER AND ENVIRONMENTAL PROTECTION

INDEX

CHAPTER 8

WATER, WASTEWATER AND ENVIRONMENTAL PROTECTION

8.1 GENERAL.

This chapter presents general requirements for the preparation of plans, specifications, and design analyses for water supply and wastewater treatment systems.

8.1.1 Water Supply Systems.

Water supply systems include sources, pumping, treatment, storage, and distribution of water used for domestic, industrial, irrigation, and fire protection purposes.

8.1.2 Wastewater Systems.

Wastewater systems include collection, pumping, treatment, and disposal of domestic and industrial wastes.

8.2 APPLICABLE PUBLICATIONS.

8.2.1 Florida Administrative Code

Rule 62-0555 Recommended Standards for Water Works

8.2.2 Puerto Rico Aqueduct and Sewer Authority (PRASA)

General Standards for the Design of Wastewater Treatment and Distribution Systems

8.2.3 Army/Air Force Basic References.

Army AEI - Architectural and Engineering Instructions, Design Criteria

8.2.2 Water Supply Systems.

TM 5-8l3-l	Water Supply: Sources and General Considerations
TM 5-8l3-3	Water Supply: Water Treatment
TM 5-8l3-4	Water Supply: Water Storage
TM 5-813-5	Water Supply: Water Distribution
TM 5-813-6	Water Supply: Water Supply for Fire Protection
TM 5-8l3-7	Water Supply for Special Projects

TM 5-813-8 Water Desalination

TI-814-02 Water Treatment, Water Supply

Ten States' Standards, Latest Edition

ETL 86-4 Paints and Protective Coatings.

ETL 1110-3-465 Design and Construction of Water Meters and Their Appurtenances at New Army Facilities.

ETL 86-7 Utility Meters in New and Renovated Facilities.

EM 1110-2-503 Design of Small Water System

8.2.3 Water Supply for Fire Protection.

AFR 86-6 Planning Criteria and Waivers for Airfield Support Facilities

MIL-HDBK-1008B Fire Protection for Facilities Engineering, Design, and Construction

TM 5-8l3-6 Water Supply: Water Supply for Fire Protection

TM 5-8l3-7 Water Supply for Special Projects

NFPA 20 Centrifugal Fire Pumps

NFPA 24 Private Fire Service Mains and Their Appurtenances

NFPA 409 Standard on Aircraft Hangars

ETL 86-8 Aqueous Film Forming Foam (AFFF) Waste Discharge Retention and Disposal

ETL 90-09 Fire Protection Engineering Criteria for Aircraft Maintenance, Servicing and Storage Facilities

ETL 1110-3-411 Design and Construction of Foam Fire Protection Systems to Protect Aircraft in Hangars

OCE Ltr Fire Protection and Detection Systems for Military Construction. Dated 5 June 87

8.2.4 Wastewater Systems.

TM 5-8l4-l Sanitary and Industrial Wastewater Collection -

TM 5-8l4-2 Sanitary and Industrial Wastewater Collection -

TM 5-8l4-3 Domestic Wastewater Treatment

TM 5-814-8 Evaluation Criteria Guide for Water Pollution Prevention, Control, and Abatement Programs

ETL 1110-3-466 Selection and Design of Oil/Water Separators at Army Facilities

EM 1110-2-501 Design, Construction, and Operation, Small Wastewater System

Military Handbook (MIL-HDBK 1005/16) Wastewater Treatment System Design Augmenting Handbook

Military Handbook (MIL-HDBK 1005/17) Industrial Pretreatment Design and Nondomestic Wastewater Control

Standards for Sewage Works (Ten States' Standards), Latest Edition

Design of Municipal Wastewater Treatment Plants (MOP 8)

Manual of Septic Tank Practice

Applicable State Criteria

8.3 PROJECT DEFINITION (10-15%).

The project definition shall contain a narrative description and a water and sanitary site plan. Construction of new facilities and major expansions to existing water and wastewater systems must comply with the procedural requirements of the applicable permitting agency or agencies having approval authority. Each state also has a department for pollution control projects involving point discharges. All designs of water and wastewater systems should be coordinated with the appropriate regulatory agency at all stages of design.

8.3.1 Narrative.

The narrative shall define the source of water for potable use and fire protection. The narrative shall also describe any pretreatment, treatment, and methods of wastewater disposal from the new facility.

8.3.2 Water and Sanitary Site Plan.

The water and sanitary site plan shall show all existing water lines and sanitary sewers. The new water lines for building service and fire flow shall be shown from the point of connection to the existing water distribution system. All necessary valves, fire hydrants, ground storage tanks, pump stations, etc. shall be indicated. Building connections for wastewater shall be shown from the building to the existing sanitary sewer system or onsite treatment system. All necessary septic tanks, grease traps, oil/water separators, treatment plants, manholes, lift stations, force mains, etc. shall be shown. All pipe sizes shall be indicated. At this stage or earlier, the designer shall request a fire flow test(s) specifying exact hydrant locations required to flow and where residual pressure is to be measured. Request shall be furnished to COE project manager.

8.4 CONCEPT DESIGN (30-35%).

8.4.1 Design Analysis.

Base all new designs on the most economical plan consistent with the applicable criteria; i.e., Army Technical Manuals, Air Force Manuals, etc. Include in the design analysis any assumptions made or source of information if not included in manuals, guides, or instructions. The design analysis shall be sufficiently complete to clearly show project requirements and utility support capacity. Prepare outline specifications as directed in Chapter 3, SPECIFICATIONS.

8.4.1.1 Water Supply Sources.

The source of the potable water supply for domestic and industrial use and fire flow demand shall be identified in this submittal. If lawn irrigation is required, the source of water for the irrigation system shall also be identified in this submittal. Provide calculations indicating available supply and pressure versus required supply and pressure. If a pump, water storage tank, or any other peripheral equipment is required, provide calculations to support the selected pump size, storage tank volume, and sizes of peripheral equipment. **Individuals experienced in fire protection systems must accomplish design of fire pumping stations**. The designer shall determine in this submittal whether a fire pump station with or without a ground storage reservoir is required.

8.4.1.2 Service Lines.

Service lines are the water lines connecting building piping to water distribution lines. The analysis for service lines shall show service line size, domestic demand, velocity and pressure drop between the water distribution line and building.

8.4.1.3 Water Distribution Lines.

The water distribution system comprises the network of piping throughout building areas and other areas of water use or fire demand, and includes hydrants, valves, and other appurtenances used to supply water for domestic,industrial, and fire fighting purposes. If new water distribution lines are required to meet fire flow demands, a Hardy Cross or similar analysis shall be provided in Chapter 5 of the Design Analysis. This shall consist of a flow analysis based on fire flow test results from the nearest fire hydrants to the points of connection to the existing distribution system and fire flow demands developed from criteria contained in MIL-HDBK-1008B and AFR 88-15 (Chapter 10) for Air Force projects. The flow through all lines shall be balanced by use of a Stet Cross analysis or other approved means. If the existing system is proven to be inadequate to supply the fire demand, revisions to the existing distribution system may be required. This will be documented even though it may not be part of the project. The designer shall request fire flow tests results through the Project Manager if not provided earlier.

8.4.1.4 Sanitary Sewers.

New gravity sanitary sewers will be sized in this submittal. The design analysis shall show wastewater flows, velocities, pipe sizes, elevations, and pipe capacities. Where new sewage collection systems are to be connected to the existing system, the existing sewage collection system shall be checked to determine whether it has adequate capacity for the additional flow. If the existing system does not have sufficient capacity, it shall be revised to handle the increased flow. The design analysis shall contain a narrative description with all necessary calculations for new wastewater lift stations and force mains showing flows, velocities, component capacities, head requirements, detention periods, etc. The design analysis shall be prepared in accordance with TM 5-814-1, TM 5-814-2, and AFR 88-15 (Chapter 11) for Air Force projects. A design analysis is required for onsite sewage treatment and disposal systems (e.g. septic tank and tile field). The feasibility of an onsite sewage treatment and disposal system where buildings are remotely located and it is not economically possible to connect to an existing wastewater collection system shall be determined. Coordination shall be made with the appropriate county sanitarian to determine soil percolation rates to use for sizing the tile fields. Permits for septic tank and tile fields are not generally required for Federal projects, but the criteria established by the local sanitary authorities is typically employed unless an appropriate justification can be cited.

8.4.1.5 Building Connections.

Building connections are the sanitary sewers connecting the building plumbing system to the wastewater collection system. A design analysis of gravity building connections is not required if the same slope for the building plumbing can be maintained to the street line. If that slope cannot be maintained an analysis shall be provided to determine pipe slope. The minimum diameter pipe shall not be less than 6 inches.

8.4.1.6 Lift Station.

If a lift station and force main are required to transport the wastewater from the building, a design analysis is required to show rational for pump selection and size of force main.

8.4.1.7 Domestic and Industrial Wastewater Treatment.

Calculate the average and peak loadings for individual unit processes including hydraulic, organic, solids, etc. Provide detailed descriptions of proposed unit processes including type, size, capacity, supporting data, and calculations showing the degree of treatment expected in each unit process, as well as the overall treatment efficiency. Provide narrative discussion of controls, instrumentation, and proposed operating sequences or methods. Include discussion of features for operator safety and comfort. Provide narrative indicating that the treatment facility was designed to simplify operation and minimize maintenance. Provide calculations to support selected equipment and pipe sizes. Provide pollution control authority design requirements.

8.4.2 Concept Design Drawings.

The water and sanitary site plan shall be adequately detailed to show new work and connections to the existing water distribution system and wastewater collection system. The proposed designs shall include sufficient details to obtain adequate concept cost estimates for all items such as lift stations, septic tanks, oil separators, etc. The invert elevations of all new and existing sanitary sewer lines and the top and invert elevations of all new and existing manholes shall be shown on concept plans. The water and sanitary site plans shall be on a minimum scale of l" = 30'. The designer shall provide any additional drawings other than those listed above which he considers necessary to show the intent of design.

8.4.3 Environmental Permitting.

A separate section shall be provided in the design analysis entitled " Environmental Permits." A separate sheet for each environmental permit contact shall be provided in the design narrative. The sheet shall be in a block format and contain the following information: Subject; Type Permit Required; Approving Agency and Address; Point-of-Contract and Telephone Number; Fee; Agency Processing Requirements; and any Special Requirements or Information. See Figure 8-1 for an example.

SUBJECT: Wastewater Treatment Plant – Construction Permit

PERMIT REQUIRED: Permit to Construct

APPROVING AGENCY: Central Florida District, FDER
(P.O.C.) Denise Judy or alt. Lee Miller

ADDRESS: Central Florida District
Department of Environmental Regulation
3319 Maguire Blvd., Suite 232
Orlando, FL 32803

Attn: Office of Domestic Permitting

(407) 894-7555

FEE: $5,000 (Includes cost of both applications.)

PROCESSING: Two Applications -- 1) App. To Const. Domestic Wastewater Facility
2) App. To Const. Reuse/Land Application System

30 days to review plus public notice period plus any time needed to incorporate FDER changes

SPECIAL REQUIREMENTS: Controls for this facility are TSS 20 mg/L, BOD 20 mg/L, and $N\text{-}NO_3$ *12 mg/L. Construction permit good for up to 6 months after construction is finished. Can be extended during construction if time expires for $50 per extension, up to 5 years.*

Systems operating manual is required (Note: FDER says these manuals are usually disappointing, because they are normally only O & M manuals and not process control—but have allowed it to suffice). The systems manual is required to be ready within the 6-month period that the "construction permit" is used to operated plan.

Figure 8-1

8.5 INTERIM DESIGN (50-60%).

8.5.1 Interim Design Analysis.

The Interim Design Analysis shall include all items in the Concept Design Analysis and any necessary updates or revisions. Provide catalogue cuts, pump curves, and any other manufacturer's information on selected equipment.

8.5.2 Interim Design Drawings.

The following specific items shall be submitted, when applicable.

8.5.2.1 Water Supply.

Provide detailed floor plans and sections of treatment plants and pumping stations with equipment layout, piping, and sufficient dimensions and elevations to physically locate all items of equipment, piping, etc. Provide hydraulic profiles.

8.5.2.2 Domestic and Industrial Water and Wastewater Treatment.

Provide hydraulic profiles. Provide detailed floor plans and sections of structures with equipment layout, piping, and sufficient dimensions and elevations to physically locate all items of equipment, piping, etc. Provide instrumentation and control schematics.

8.5.2.3 Water Distribution and Wastewater Collection Systems.

Provide a site plan showing all existing and new valves, fire hydrants, manholes, pumping stations, laterals, meters, etc. Include sizes of all water lines, sanitary sewers, and force mains. Invert and rim elevations are required for all manholes. Provide profiles of gravity sewers. Double lines are required for profile piping. Provide details for connecting new lines to existing systems.

8.6 FINAL DESIGN (UNREVIEWED 100%).

8.6.1 Final Design Analysis.

The Final Design Analysis shall be a refinement of the Interim Design Analysis. Design analysis shall include all references for design assumptions. Design analysis shall incorporate all accepted comments from the previous design submittal. All pipe-sizing computations shall be included in analysis. Piping analyses shall show design flows, pipe sizes, friction factors, slopes, lengths, elevations where applicable, conducted quantity, and velocity in each line. Provide flow diagrams in the analysis. Determination of pump heads shall be based on complete takeoff of friction losses and static heads. Systems head curves are required for all pumping systems. Pumping stations with multiple pumps shall be provided with pumping curves for the individual pumps and any combination of possible pump operation that will occur.

8.6.2 Final Design Drawings.

Final plans shall be the refinement and completion of the interim drawings. All comments relating to interim or concept design shall be incorporated in the final drawings. Where crowded conditions exist due to close proximity of other phases of the work, sufficient sections and elevations shall be shown to indicate clearly the exact location of new facilities. The number of elevations and details shall be sufficient to allow construction and installation of the work without additional design work by the contractor. Where equipment connection details are shown, indicate all required valves, trim, gages, and fittings required. Coordinate with the specification requirements and make sure that valves, fittings, etc., that are specified to be furnished with each piece of equipment are included in the detail. Final plans shall show all pipe sizes. Catwalks, ladders, platforms, access panels, and doors required for operation and maintenance of equipment, valves, and accessories shall be detailed on the drawings. Performance characteristics for all items of equipment shall be placed in carefully prepared equipment schedules. Equipment characteristics specified in "Note" fashion, or in random locations on the drawings are not acceptable. Equipment characteristics selected shall not be restrictive to any one manufacturer but must be competitive among at least three major manufacturers. **Manufacturer's trade names shall not be shown on the drawings**. Electrical characteristics, horsepower ratings, classification of NEMA type, if applicable, and except in special cases, rotative speeds shall not be included in equipment schedules. Location of equipment and piping shall be completely coordinated with other features of the project; architectural, plumbing, mechanical, structural, electrical, etc. Profiles shall be provided for all new sanitary sewers and force mains. These profiles shall indicate elevations, depth of bury, and interfering utilities which may be encountered. Profiles for building connections may not be required depending on length of run, topography and state permitting requirements. Complete construction details of water and sanitary sewer utilities as well as layouts shall be required on final plans. A legend shall be provided on drawings to clearly differentiate between existing and new construction. Existing construction is generally indicated by light symbols and new construction is indicated by **heavy** black symbols. Existing construction data such as pipe sizes, elevations, valves, and fire hydrant locations, etc., pertinent to new construction shall be included on the drawings.

8.6.3 Draft Specifications.

Marked-up guide specifications shall be included in this submittal. Specifications shall not be restrictive. Generally, the description shall be such that at least three major manufacturers can meet the specified requirements. Do not use trade names in the specifications unless a sole source authorization has been approved. The subparagraphs on "Electrical Work" shall be carefully coordinated with the electrical section of the specifications. There shall be no conflicts as to which section covers starters, controls, or wiring; and no conflicts as to the type of starters required for the individual items of equipment.

8.6.4 Environmental Protection.

Guide Specification Section 01410, Environmental Protection, shall be included in this submittal. A list of all required construction permits, existing environmental permits, and new environmental permits shall be included in this specification section.

All permits obtained by the user or required to be obtained by the user shall be listed by title, permit number, permitting agency, effective date and expiration date. The list shall include but is not limited to the following:

Federal Aviation Administration Construction
General Permit for New Stormwater Discharge
State Wetlands Dredge and Fill Permit
Construction Permit for Water Line Extensions
Construction Permit for Sanitary Sewer Work
Air Pollution Construction Permit
Consumptive Use Permit for Water (Florida - water wells)

A separate list in the same format as above will also be prepared for all permits to be obtained by the contractor. Permits to be obtained by the contractor include but are not limited to the Well Drilling Permit.

8.7 READY-TO-ADVERTISE (100%).

All final design drawings, specifications, and cost estimates will have incorporated comments from the preceding reviews before submittal as Ready-To-Advertise.

8.8 TECHNICAL REQUIREMENTS.

8.8.1 Standard Systems Criteria.

8.8.8.1 Building Services.

High service pumping and distribution facilities shall be designed to provide maximum hourly system demand without development of a distribution pressure lower than 20 psig (FL DEP 62-555.320).

(a) Water Service Lines. Provide exterior water service line to all new buildings from existing and/or new water distribution systems. Size building water service line to meet the peak building demand as indicated in TM 5-810-5 for Army projects and in accordance with AFI's and Mil-Handbooks for Air Force projects. The pressure drop through the service line will not exceed l0 psi at the peak building demand. Provide a gate valve or service stop near the connection point to the distribution system. The designer shall insure that all state and local cross connection requirements have been incorporated into the design.

(b) Building Connections (Sanitary). Building connections will be of either the gravity type or the force main type as required by the building site conditions. Gravity type sanitary sewers are preferable, if feasible, and will be constructed of 6-inch minimum size pipe on an appropriate slope to achieve a velocity (or equivalent) cleansing velocity of two (2) feet per second. Where gravity type building connections to a sanitary collection system are not possible, provide pneumatic ejectors or sewage pumps in the building or a lift station outside the building. The selection of pumps or ejectors will be based on the economy of initial installation. A design analysis of gravity sanitary sewers for building connections is not required if the slope for the building plumbing can be maintained to the street sewer. However, if the slope cannot be maintained an analysis demonstrating maximum achievable velocity during peak flow must be provided with the proposed slope. Pipe diameter and slope must be shown on the drawings. Duplex units will be provided where ejectors or pumps are required. The capacity of each unit will be sufficient to handle the peak rates of flow. Other design characteristics will conform to TM 5-814-2, Sewage and Industrial Waste Pumping Stations.

8.8.1.2 Fire Protection.

(a) Distribution Lines and Fire Hydrants. Provide distribution lines and additional fire hydrants, as necessary, in the building area in accordance with the applicable portions of TM 5-813-1, Water Supply Sources and General Considerations, and TM 5-8l3-5, Water Supply: Water Distribution Systems, and MIL-HDBK-1008B. The residual flow pressures at design flows at fire hydrants will not be less than 20 psi. Water lines shall be installed parallel to streets and roads, but not under roadway pavements, except for crossings. The fire demand is determined by the sum of the fire flow, 50% of the average domestic demand rate, and any industrial demand that cannot be reduced during a fire period. See TM 5-813-1,(or AFI’s and Mil-Handbooks for Air Force projects). Provide fire hydrants in accordance with TM-5-813-5, NFPA 24 and MIL-HDBK-1008B. Any point of the building should be within 350 feet of at least 2 hydrants. Fire hydrants shall be installed with not less than a 6-inch connection to a supply line and be valved at the connection.

(b) Building Sprinkler Supply Lines. Sprinkler supply lines shall be at least the size required by the National Fire Protection Association. The adequacy of the existing or proposed distribution system and sprinkler lines to meet the sprinkler and hose stream demands as indicated in MIL-HDBK-1008B, Fire Protection for Facilities-Engineering Design, and a fire flow analysis or other approved means of analysis must justify Construction. Where required, augment the existing distribution system to provide at least a 15-pound residual pressure at the highest sprinkler heads in the building at design fire demands. Provide cutoff valves on the supply lines. These shall be located not less than 25 feet nor more than 50 feet from the face of the building, which they are to serve. They may be of either the post indicator type, or the rising stem and yoke type installed in a pit, as dictated by the proposed construction provided for that area. Use post indicator valves generally in grassed areas, and use the rising outside stem and yoke type installed in underground pits in paved areas. Fire pumping stations shall comply with MIL-HDBK-1008B and NFPA Codes 20, 24, and 409, as appropriate, and **shall be designed by persons experienced in design of fire protection systems**. The design of a fire pump or series of fire pumps shall not exceed 1500 GPM each without approval of the Corps of Engineers. Provide standby fire pumps where required by NFPA 409.

8.8.1.3 Sewage Collection System.

(a) Gravity Sewers. Where more than one building is involved, use gravity sewers. Design is to conform to the applicable requirements of TM 5-814-l. Size gravity sewers to discharge the expected peak rate of flow. Design pipes to run not more than 80% full, except that regardless of the design quantities, the minimum size of gravity sewers is 8 inches. Gravity sewers shall normally be laid on a sufficient slope to provide a velocity of at least 2.5 feet per second when the pipe is flowing full and 2.0 feet per second at the average rate of flow. Locate gravity sewers by the topography of the site to minimize excavation.

(b) Force Mains and Sewage Lift Stations. Where more than one building is involved, if gravity type sewers cannot be provided, sewage pumps shall be installed in a sewage lift station constructed on the lowest terrain in the vicinity. Since force mains do not require a specific grade for satisfactory operation, they shall be constructed as straight, short, and shallow as possible. Routings for force mains shall generally follow existing right-of ways, roads, or utility corridors. In the Mobile District, force mains are generally installed a minimum of 30 inches below final grade. Force mains and sewage lift stations shall conform to the applicable requirements of TM 5-814-2 (or AFI's and Mil-Handbook for Air Force projects), Pumping Stations and Force Mains. The capacity of the lift station shall be sufficient to handle peak rates of sewage flow, determined in accordance with TM 5-814-l. Sewage pumps must be designed to meet actual head conditions of the force main provided for the lift station. The design point on the pump characteristic curve shall be justified by plotting this curve against the system head-capacity curve. The system head curve shall be obtained by plotting the static lift plus the friction head at various flow rates. Where pumps operate in parallel or series, combined curves shall be provided. Intersection of characteristic curve with system head curve shall be the design operating point. Where appropriate, grinder-type pumps shall be considered.

(c) Septic Tank and Tile Field. Design septic tanks and tile fields in accordance with TM 5-814-3, Domestic Wastewater Treatment, Manual of Septic Tank Practice, and applicable state criteria. Prefabricated septic tanks approved by the state or local authority may be used providing the minimum wall thickness is 4 inches and calculations are provided for structural soundness.

(d) Oil/Water Separators. Oil/water separators shall be provided for process wastewaters in accordance with ETL 1110-3-466 for Army projects and as required by state and local regulators for Air Force projects. Separators shall be of the prefabricated type or built in place. Oil/water separators shall be designed to meet the effluent requirements for pretreatment by the EPA and/or applicable State Agency. The effluent from the oil/water separator shall be routed to a sanitary sewer or an industrial sewer. Oil/water separators shall be designed so that large quantities of storm water are not processed through the separator. Separators shall be installed to meet installation requirements for containment of hazardous wastes as required by the applicable state agency, the storm water pollution prevention plan, and the spill prevention and control plan. Overall project designs should be coordinated in order to minimize peak flow rates into separators and to prevent any extraneous flow into a separator. Before designing in a separator into a project permission must be obtained due to environmental constraints at some bases.

8.8.1.4 Treatment Plants.

Specific instructions for water treatment plants and/or wastewater treatment plants are provided in the Statement of Work.

8.8.1.5 Seismic Provision.

All projects shall include appropriate provision for protection of piping, equipment, and underground utilities against damage from seismic events in accordance with TM 5-809-10, Seismic Design for Buildings and Air Force projects using the latest recognized civilian standard, such as ASCE.

8.8.1.6 Fire Protection Using AFFF Systems.

Fire protection using AFFF Systems shall comply with the requirements of ETL 86-8. Provide a means for containment of and disposal of AFFF foam solution runoff, as per para 10, and as revised by ETL 86-8: "Aqueous Film Forming Foam (AFFF) Waste Discharge Retention and Disposal." Containment and disposal must meet the requirements of the applicable State Agency, and shall be a part of permitting requirements. Other options that can be approved by the installation and state regulatory agencies should be presented as economic alternatives before the 30% design is finalized.

8.8.2 Supplemental Design Criteria.

8.8.2.1 Water Supply/Water Distribution.

Minimum cover to finished grade over Water Mains shall be 30 inches up to 8" diameter; 10" or larger shall have 48" cover.

(a) Water wells shall conform to AWWA Standard A-100; TM 5-813-1 and applicable State Public Health Department criteria for public water supplies. Specification for water wells shall be based on specification 02670.

(b) The designer through the Jacksonville District geologist (CESAJ-EN-GG) shall coordinate design of water wells.

(c) Vertical turbine pumps larger than 5 hp shall conform to AWWA E-101 and CEGS 11222.

(d) Design of water treatment plants shall conform to TI 814-02 and Mil-Handbooks as appropriate and any applicable State criteria for public water supplies; and Recommended Standards for Water Works (Ten States' Standards).

(e) Small isolated facilities shall utilize a hydro-pneumatic pressure tank and, if appropriate, a ground storage reservoir as discussed below. Small systems shall normally be located in a protective building. Where permitted by the State, pitless well adapters may be used. Use of well pits is prohibited.

(f) Supply and distribution piping shall comply with TM 5-813-5 and appropriate Mil-Handbooks. Piping materials shall be based on specification 02660.

(g) Water storage designs shall comply with TM 5-813-4 and AWWA D100. Specifications shall be based on CEGS-13210.

(h) Hydraulic analyses shall normally be made using a value of C = 100 for the roughness co-efficient; however, consideration should be given to the use of co-efficients greater than 100 when specifying concrete or plastic pipe. Changes in co-efficients from new pipe to an aged pipe should be considered to insure that excessive velocities are not generated in new piping by using only co-efficients for aged pipe.

(i) Fire hydrant branches shall not be less than 6 inches in diameter, shall be as short in length as possible, and shall have a gate valve and box.

(j) A minimum 10-foot horizontal separation shall be maintained between any type of sewer and water main in parallel installations. Where it is not possible to maintain a 10 foot horizontal separation, the water main must be laid in a separate trench or on an undisturbed earth shelf located on one side of the sewer or force main at such an elevation that the bottom of the water main is at least 18 inches above the top of the sewer. Where sanitary sewers, force mains and storm sewers must cross a water main with less than 18 inches vertical distance, both the sewer and the water main shall be constructed of ductile iron pipe(DIP)(excluding storm sewer) at the crossing. Sufficient lengths of DIP must be used to provide a minimum separation of 10 feet between any two joints. All joints on the water main within 20 feet of the crossing must be mechanically restrained. A minimum vertical clearance of 6 inches must be maintained at all crossings.

(k) Where water lines must cross sewers they shall conform to the requirements of TM 5-813-5, CEGS Guide Specifications and applicable state criteria.

(l) Water lines crossing railroads shall be installed in protective casings conforming to the requirements of American Railway Engineering Association (AREA), Volume 1. Design should specify method of construction for each particular site (i.e., ut vs. jacking). The designer shall obtain permits from the railroad authority, as required. Permit application procedure and submittal should occur as soon as practicable.

(m) Water lines located in airfield pavement shall conform to the requirements of TM 5-813-5.

(n) Control valves shall be provided on distribution systems in accordance with TM 5-813-5.

(o) Air release and vacuum relief valves shall be provided in accordance with the requirements of TM 5-813-5.

(p) Fire hydrants shall be provided in accordance with the requirements of TM 5-813-5; TM 5-813-6; NFPA 24, Outside Piping; and MIL-HDBK-1008B. Hydrants should not be located closer than 25 feet to a building and should be located not more than 7 feet nor less than 6 feet from the edge of a paved roadway surface. Residual pressures at fire hydrants shall not be less than 20 psi when flowing at the desired rate.

(q) Thrust blocking shall be provided in accordance with TM 5-813-5; and specification 02660, Water Lines.

(r) Where the base distribution system is unable to provide the fire flow demand at the required residual pressure, the designer shall analyze the existing distribution system and provide pumping equipment and ground storage tanks, if necessary. A complete design analysis is required, including fire flow test data. Pumping stations shall conform to the requirements of NFPA 20 and TM 5-813-6. Pumping stations for aircraft hangars shall conform to TM 5-8l3-6 and NFPA 409, except that fire pumps shall be diesel engine driven. Provide post indicating cutoff valves in accordance with NFPA 24.

(s) Water for domestic purposes and fire protection for special projects such as reserve centers shall be provided in accordance with the requirements of TM 5-813-7.

(t) Service lines to new buildings shall be sized to meet peak building demands in accordance with TM 5-810-5. Pressure drop between the connection to the distribution line and the building shall not exceed l0 psi at peak rate. Provide control valves, in accordance with specification 02660, Water Lines.

(u) All water lines, water wells, and storage tanks shall be effectively sterilized with chlorine solution and tested bacteriologically safe in accordance with AWWA Standards and as specifically required by state and local drinking water regulations before placing them in service. See specification 02660 and 02670; and 13210.

(v) Storage reservoirs shall be provided with cathodic protection when required. Questions on cathodic protection should be addressed to the Mobile District Cathodic Protection Specialist. Coatings and paint shall conform to ETL 86-4.

(w) Hydropneumatic Pressure Systems:

(l) Use at small activities where the demand is not enough to justify any other type of storage. Design the tank to meet the appropriate pressure vessel requirements. Provide air compressors, safety valve, and sight glass, to show the air/water ratio when diaphragm-type tanks are not practical. Typically, the tank should be designed as a branch connection to prevent excessive air entrainment in the distribution system.

(2) The operating pressure shall be 40 psig. Absolute minimum operating pressure shall be 20 psig.

(3) Provide duplex high service pumps to meet the peak 4-hour demand of 2.5 times average flow. When water well source is inadequate to provide peak 4-hour demand, investigate the feasibility of providing ground storage or a pressure tank equal to 40 times the well pump.

(4) Tank capacity. Conventional tank capacity shall be based upon a withdrawal, in gallons, of 2-l/2 times the GPM capacity of the pump and a low-water level of not less than l0 percent of total tank capacity or 3 inches above top of tank outlet, whichever is higher. Table l indicates high water levels and withdrawals for efficient operation of tanks with bottom outlets and a l0 percent residual. Using the table, the tank capacity may be determined as per Example l:

Example l: Determine the tank capacity when pump capacity is 150 GPM and tank operating pressure range is 40-60 psi. Referring to table 1, the withdrawal from the tank is 24 percent of the tank capacity.

$$\text{Total tank capacity} = \frac{2.5 \text{ X } 150 \text{ GPM}}{0.24} = 1{,}562 \text{ gallons}$$

TABLE I

HYDROPNEUMATIC TANK HIGH-WATER LEVELS AND WITHDRAWALS

Pressure Range (PSI)	High-Water Level (% of Total Tank Capacity)	Withdrawal (% of Total Tank Capacity
20-40	43	33
30-50	38	28
40-60	34	24
50-70	32	22
60-80	28	18

(5) Compressed Air. Compressed air is supplied for tank operation according to the tank capacities. For tank capacities up to 500 gallons, provide l.5 CFM. Provide 2.0 CFM for capacities from 500-3,000 gallons and each additional 3,000 gallons or fraction thereof. Quantities are expressed in CFM free air at pressure equal to the high-pressure maintained within the hydropneumatic tank.

(6) Controls. The controls of a hydropneumatic system shall maintain the predetermined pressures, water levels, and air-water ratio within the tank. When duplex pumps are provided, controls shall start only one pump at a time; pumps shall be operated alternately. Pumps shall operate simultaneously only when the predetermined low pressure cannot be maintained by a single pump. Controls shall admit compressed air into the tank only when tank pressure at high-water level is below normal.

(7) If required, provide a water meter on the service line from the pressure tank.

(8) Provide a chlorine disinfection system for water to be consumed by humans. Size to provide **1** mg/l chlorine residual when flowing at the peak 4-hour rate. Consider using a hypochlorite feeding machine for intermittent pumping rates up to 200 gpm or when maximum chlorine demand is less than 3 pounds per day. Chlorine gas shall be used for larger pumping rates or chlorine demands. Provide a minimum of 2mg/1-chlorine residual at the distribution system.

(9) Refer to the publication "Handbook of Chlorination" by George White (Van Nostrand Reinhold) and manufacturer's literature for details of design of chlorination systems.

(10) Diaphragm-type tanks shall be designed and sized in accordance with the manufacturer's instructions.

(y) Asbestos-cement pipe **shall not be specified** for water lines.

8.8.2.2 Wastewater Treatment and Disposal.

(a) Design of on site treatment/disposal facilities shall conform to applicable criteria published by the appropriate state regulatory agency and Mil-Hdbk 1005/16. When appropriate, a "mound" system shall be considered where high water tables or impervious layers of soil exist. Other alternative systems may be considered when approved by the installation facility and environmental regulators.

(b) Where soil conditions at the site are such that a septic tank/tile field system cannot be used, consideration shall be given to use of a septic tank subsurface sand filter system. Design must conform to the above referenced documents for septic tanks.

(c) Gravity Sewers (TM 5-814-1)

(l) Provide a minimum of 24" to 30" of cover over pipe. Provide a minimum cover to finished grade over force mains of 48".

(2) Manholes are required at the end of laterals and at each change of direction or slope.

(3) Distance between manholes shall not exceed the following:

Diameters less than 18"	400'
Diameters 18" and larger	600'

(4) Drop connections are required at manholes when the invert of the inlet pipe is more than 18 inches above the manhole floor.

(5) Minimum size for building connections is 6 inches in diameter.

(6) Sewers shall be laid with sufficient slope to ensure cleansing velocities (2 fps when flowing full or half full).

(7) Capacity of building connections shall be based on fixture units.

(8) Minimum size sanitary sewers between manholes shall be 8 inches in diameter.

(9) Use Mannings formula for computing gravity flows in sewers. Use n = 0.013 for pipes 12 inches or smaller and n = 0.014 for pipe larger than 12 inches.

(10) Deep sewers shall be analyzed for excessive loads using the equations of TM 5-814-1, Paragraph 12.

(11) Selection of pipe materials shall consider structural loads, soil conditions, and characteristics of transported wastes.

(l2) Design analyses are required for sizing all 8 inch and larger sewers.

(13) Asbestos-cement pipe **shall not be specified** for gravity sewers or force mains.

(d) Pumping Stations (TM 5-814-).

(l) Force mains shall be analyzed for water hammer conditions.

(2) Minimum size force mains where nonclog pumps are used is 4 inches. Smaller pipe sizes can be considered when grinder pumps are used.

(3) Small lift stations shall be of the wet-pit, submerged-pump type.

(4) Capacity of pumping stations shall be sufficient to handle maximum rates of flow when the largest pump is out of service. See TM 5-814-2 for determining pumping rates.

(5) Overflows shall not be provided.

(6) A complete design analysis is required.

(7) Force mains shall be provided with a minimum of 24" to 30" cover.

(8) Systems head curves are required for all pumping systems.

(e) Wastewater treatment plant designs shall conform to TM 5-814-3; applicable State criteria; and Recommended Standards for Sewage Works (Ten States' Standards). Designs shall be based on meeting NPDES discharge permit limitations for the site, as provided by the State or EPA, depending on who has authority.

(f) Treatment plants for industrial wastes shall conform to Mil-Hdbk 1005/17 and TM 5-814-8. Designs shall be based on meeting NPDES discharge permit limitations for the site or meeting owner of the final treatment systems requirements.

(g) Wastewaters containing oils shall be treated in accordance with the requirements of local environmental authorities. Oil-water separators shall be provided on effluent lines from aircraft and vehicular washracks for pretreatment prior to discharge to a central sewage collection system. Where central sewage systems are non-existent, package, coalescing type oil/water separators meeting State discharge criteria are required. Grit separators are required ahead of separators serving vehicle washracks. Prior to design of separators, permission of Base personnel is required because of environmental constraints.

(h) Special Requirements for Fire Pump Stations/Fire Booster Stations. A comprehensive transient analysis shall be performed and submitted for pumping systems required to provide water pressure and flow for sprinkler systems and/or standpipes. The analysis shall be a computerized model of the pipe, control and relief fittings, and pumps required by the A-E to support the fire suppression system being designed. A report describing the analysis procedures, control methods, need for corrosion control, etc., shall be submitted with the design analysis. As a minimum requirement, the following shall be included in the analysis:

(1) Pump start and stop against a closed (no flow) system such as motor or engine exercising only.

(2) Single pump running with other pumps coming on line to supplement the single pump.

(3) Pump(s) trip in a single run mode and a multiple pump trip with all pumps tripping at the same instance.

(4) Pump(s) start and stop at intermediate design flow; e.g., 35 to 50 percent.

(5) Analysis of all pressure relief or reduction elements such as air chambers, surge relief valves, by-pass, etc.

All assumptions used to model the systems shall be clearly explained. In addition, any physical phenomenon anticipated to occur shall be described so that Base operations personnel can be made fully aware of these phenomenon and take any appropriate actions required.

CHAPTER 9

ARCHITECTURAL

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CHAPTER 9

ARCHITECTURAL

9.1 GENERAL.

9.1.1 Scope.

This chapter states criteria, requirements, and guidance for architectural design. Specific requirements in this chapter supplement the requirements of Chapter 1, titled GENERAL INSTRUCTIONS. All required documents, including the drawings and the design analysis, shall be prepared in accordance with Chapter 2, titled PRESENTATION OF DATA.

9.1.2 Architectural Quality.

The objective of the Corps of Engineers is to obtain attractive cost-effective buildings which are designed using sound technical knowledge and which are constructed using recognized, good commercial building industry practices. The design shall incorporate those characteristics which will provide buildings with present and continuing utility, durability, and desirability, provide a safe and healthy environment, and which will be economical to maintain for the life of the building.

9.2 APPLICABLE PUBLICATIONS.

The following publications shall be used to provide a complete design and meet all requirements of applicable codes and governmental requirements.

Uniform Building Code, latest edition.

Council of American Building Officials (CABO), One and Two Family Dwelling Code, latest edition.

Military Handbook 1190, latest edition.

NFPA, latest edition, applicable portions.

Life Safety Code, NFPA 101, latest edition.

Military Handbook 1008C.

Department of Army or Air Force Technical Manuals as applicable.

Installation Design Guide as applicable.

Architectural and Engineering Instructions (AEI), latest edition (published by the Corps of Engineers).

Requirements established by the installation Department of Public Works office (Army projects), Base Civil Engineer's office (Air Force projects), or the using agency.

Other model codes that may be in use at a particular installation. (Such as Standard Building Code, etc.)

Requirements of state and local governmental agencies (health department, environmental agency, etc.) that are applicable.

The U.S. Air Force Project Manager's Guide to Project Definition, USAF/CE September 1994

An Overview of Project Definition - Project Definition Tools, November 1994.

9.3 PROJECT DEFINITION (10% - 15%).

This submittal consists of one or more single line schematic floor plans which effectively indicate to the using agency that the function, circulation, and life safety issues have been assessed and can be met by the proposed design. At least one major elevation (preferable the front elevation) for each submitted building is required. A site plan is required to indicate the building orientation and circulation to the building entrances. The site plan shall be coordinated with the requirements of Chapter 4, titled SITE DEVELOPMENT.

9.3.1 Charrettes.

When called for in the SOW, the design process known as the "Charrette" for obtaining a schematic design shall be used as described in "The U.S. Air Force Project Manager's Guide to Project Definition" published by USAF/CE September 1994. Additional information on this design process is also available through the Air Force publication "An Overview of Project Definition - Project Definition Tools" on an Audio Visual Program, in 35 MM slides, on disk in Microsoft Power Point, in overhead view graphs, and with a briefing script that can be modified or abbreviated depending on the briefing forum.

9.4 CONCEPT DESIGN (30% - 35%).

The minimum requirements for this submittal consist of floor plan(s) drawn to appropriate scale, fire protection information as required by the paragraph 9.4.2.10 titled Life Safety Analysis Plan, exterior building elevations, typical wall sections to indicate material usage and structure, and a design narrative as described in the paragraph 9.4.1. titled Concept Design Analysis Additional drawings may be required at this submittal due to the complexity of the project (i.e., hospitals research facilities, blast resistant structures, etc.) to adequately describe the proposed design.

9.4.1 Concept Design Analysis Narrative.

The following specific items shall be included when applicable:

9.4.1.1 General Description of the Project.

State the purpose, function, and capacities in sufficient detail to delineate and characterize functional features and the desired image or visual appearance of the project. The narrative shall reflect the regional architecture as well as the visual characteristics of the existing facilities around the site.

9.4.1.2 Basis of Design Summary.

Provide a summary of the Basis of Design including, but not limited to, the following:

(a) State the building construction type and occupancy classification appropriate to the model code(s) in use.

(b) State the design wind speed and velocity pressure used in the design.

(c) List the functional areas and their relationships.

(d) List the space allocations.

(e) State the energy conservation measures used in the design.

(f) State the noise control criteria established for the design.

(g) State any requirements for exterior finish materials and color selection. Indicate that consultation has occurred with the Base Civil Engineer's Office, for Air Force projects, to review the installation's program of architectural compatibility and the finish materials and colors selected are in accordance with the installation's approved standards.

(h) List special requirements such as EM1/RF1 shielding, security requirements, raised flooring, blast resistance, and fallout protection.

9.4.1.3 Technical Criteria.

List the technical criteria used to guide the design work.

9.4.1.4 Building Organization Analysis.

Submit, as necessary, any graphic design aids such as affinity drawings, spatial organization and relationship matrices, and space layout sketches in a sequential order, with sufficient narrative to indicate the reasoning and justification for major design decisions. Any provisions for future expansion shall be indicated, including schedules for phasing.

9.4.1.5 General Design Statement.

The designer shall state the assumptions and rationale behind all major facility design decisions including, but not limited to, discussions of the following:

(a) Orientation to the sun, wind, and water (when applicable).

(b) The relationship to any surrounding natural or manmade environment.

(c) The interface with any contiguous traffic circulation.

(d) The visual impact of the facility with regard to the overall area.

(e) Justification for not orienting Army buildings on the site so that the long axis of the building is in the east-west plane as required by the AEI, Design Criteria.

9.4.1.6 Building Systems Analysis (Applicable only where no specific base criteria exists.).

Include any substantiating material to support the selection of architectural materials or systems. Selection shall be based on a comparison of several alternate systems which shall be presented. Indicate the economic decision process (comparative cost analysis method, life-cycle analysis method, or other techniques used) and any other rationale utilized in the selection of the various systems. It must be evident that the designer has adequately conceived the project as a whole and that the systems selected represent the maximum value that can be obtained for the intended result. The following are some, but not necessarily all, of the systems that should be investigated:

(a) Exterior wall systems.

(b) Passive solar systems.

(c) Fenestration.

(d) Roof systems.

(e) Interior partition systems.

(f) Openings in interior partitions (doors, windows, etc.).

(g) Ceiling systems.

(h) Floor systems.

(i) Integrated building systems.

(j) Noise and/or acoustics control measures.

(k) Special equipment such as trash handling systems.

(l) Vertical transportation systems (elevators).

9.4.1.7 Design Calculations.

Submit complete calculations for the following:

(a) Gross building areas in accordance with the AEI, Design Criteria.

(b) "U" values for each exterior construction assembly (walls and roofs).

(c) Calculations for toilet fixture count.

9.4.2 Concept Design Drawings.

9.4.2.1 Composite Floor Plans.

When the main floor plans must be drawn in segments in order to comply with the requirements for the proper scales, provide a composite floor plan for each floor level. These plans shall show the following:

(a) The general building layout showing exterior walls, interior partitions, and circulation elements (stairs, elevators, corridors, etc.) drawn to scale.

(b) The identification of major areas and their functional relationship.

(c) Overall building dimensions, out to out.

(d) Planning grid or column lines where applicable.

(e) Match lines indicating larger scale floor plan segments.

(f) Cross-references for enlarged floor plans and building sections.

(g) Gross area tabulations.

9.4.2.2 Floor Plans.

Provide a floor plan or floor plan segments, 1/8-inch scale minimum, 1/4-inch scale for Health Care facilities, for each floor showing functional arrangement and circulation elements, drawn to scale. In addition, the following shall be shown:

(a) Planning grid and/or column lines.

(b) All major overall dimensions.

(c) Type of occupancy in each area.

(d) Finish floor elevations for each floor or change in floor level.

(e) Openings in walls (doors, windows, etc.).

(f) All major equipment.

(g) Furnishings layouts or typical rooms where required.

(h) Gross floor area tabulations on the first floor plan sheet.

(i) Cross-references for sections and details.

(j) Provisions for the handicapped where required.

(k) Reflected ceiling plans.

9.4.2.3 Roof Plan.

Provide a roof plan showing the following:

(a) Planning grid and/or column lines.

(b) Overall dimensions.

(c) Indication of roof slope and drainage.

(d) Roof accessories (skylights, roof scuttles, etc.).

(e) Major roof-mounted equipment.

9.4.2.4 Demolition Plans.

Floor plans showing demolition work in sufficient detail to indicate all existing building materials and finish conditions are required for renovation and modification projects. Drawings shall be of sufficient detail to indicate "existing to remain," "existing to be removed," and new work and materials. Contractors are not required to site verify correctness or completeness of renovation and modification contract drawings and specifications, therefore, the drawings shall be complete with adequate detail and descriptions of existing materials, assemblies, and systems (type, thickness, quantity spacing, length, width, height, etc.) to enable the contractor to bid on the project.

9.4.2.5 Building Elevations.

Provide building elevations showing the exterior design of all major elevations. Each elevation shall show the following:

(a) Planning grid and/or column lines.

(b) Building masses and fenestration.

(c) Identification of all major building materials.

(d) Roof accessories, when visible in elevations.

(e) Major roof-mounted equipment.

(f) Indication and elevation of all floor lines.

9.4.2.6 Building Sections.

Provide building sections as necessary to demonstrate the coordination of the structural, mechanical, and electrical systems. In addition, the following shall be shown:

(a) Planning grid and/or column lines.

(b) Structural system.

(c) Changes in floor levels.

(d) Finish ceilings.

(e) Floor-to-ceiling and floor-to-floor heights.

(f) Floor elevations.

(g) Spaces to be used by the lighting and HVAC systems

(h) Adjacent grades.

9.4.2.7 Typical Wall Sections.

Provide at least one unbroken, typical wall section (3'4-inch scale preferred). All sections shall be fully noted. These sections shall show the following:

(a) Structural system.

(b) Exterior wall and roof assemblies.

(c) Ceiling systems.

(d) Floor-to-ceiling and floor-to-floor heights.

(e) Floor elevations.

(f) Spaces to be used by the lighting and HVAC systems.

(g) "U" values through walls and floors.

9.4.2.8 Finish Schedules.

Finish schedules requirements are included in Chapter 10, titled INTERIOR DESIGN.

9.4.2.9 Details.

In addition to the above requirements, show details of any design significant features and any sections necessary to demonstrate the required coordination of the various building systems.

9.4.2.10 Life Safety Analysis Plan.

Unless specifically deleted by the SOW, a Life Safety Analysis Plan shall be submitted for each floor at the Project Definition Phase and the Concept Design phase. Life Safety Analysis Plan sheets shall be referenced as LSA-1, LSA-2, etc., and placed after the Architectural Drawing sheets in the contract drawing submittal set. Include the following data and provide a legend for symbols used on the drawings. The legend shall include the following information:

(a) Type of occupancy.

(b) Type of construction.

(c) Fire/smoke compartments.

(d) Exit width calculations and number of exits.

(e) Location and rating of walls (1 hr., 2 hr., etc.).

(f) Door labels.

(g) Door hold open devices.

(h) Fire extinguisher and/or fire hose cabinet locations and details.

(i) Egress distances form most distant point to exit.

(j) Smoke proof doors.

(k) Exit lights.

9.4.2.11 Coordination

Preliminary coordination with work of other technical disciplines shall be implemented as outlined in the paragraph 9.6.3 titled Coordination.

9.5 INTERIM DESIGN (50% - 60%).

9.5.1 Interim Design Analysis Narrative.

The Interim Design Analysis narrative shall include all items in the Concept Design Analysis narrative and any revisions necessitated by comments about the Concept Design submittal. In addition the following specific items shall be included when applicable.

9.5.1.1 Safety and Accessibility Requirements.

Assure compliance in all aspects with the latest requirements of the following where applicable:

(a) Occupational Safety and Health Agency (OSHA).

(b) Uniform Federal Accessibility Standards (UFAS).

(c) Americans with Disability Act (ADA).

9.5.1.2 Graphics.

Verify the graphics requirements with the Corps of Engineers Interior Designer (CESAM-EN-DR) and justify the system selected. This shall include graphics for the building(s) and the site.

9.5.2 Interim Design Drawings.

These drawings shall include, but are not limited to, the following items:

9.5.2.1 Concept Design Review Comments.

Implement Concept Design review comments into the drawings and provide annotated comments (responses) describing the action taken for each comment (changes or additions to the design, reasons for the design, directions received from the user, etc.).

9.5.2.2 Building Plans.

Provide plans for each floor, roof, and ceiling showing dimensions, functional arrangement, and equipment for all areas, including corridors, exits, stairs, and utility spaces. The relationship of the building to exterior access, vehicle parking, service areas, etc., shall be indicated on site plans. Individual treatment shall be given to special design or items involving deviation from normally accepted standards. All column lines shall be designated to aid in locating project components and all fire rated construction shall be indicated. Show indications of phased construction if required. Thoroughly cross-reference section cut symbols on plans and elevations to detail sheets.

Identify fire walls and smoke partitions. Include door and window numbers, space names, section cuts, etc. Complete door and window details to minimum of 60%.

9.5.2.3 Schedules.

The drawings shall include door, window, and equipment schedules. Schedules need not be complete at this point, however, they shall be sufficient to indicate the door and window sizes and major equipment items.

9.6 FINAL DESIGN (UNREVIEWED 100%).

9.6.1 Final Design Analysis Narrative.

The Final Design analysis narrative shall include all items in the Interim Design analysis narrative and any revisions necessitated by comments about the Interim Design submittal. In addition the following specific items shall be included when applicable.

9.6.2 Drawings.

(a) Complete to the extent required for the Ready To Advertise Submittal. Drawings are to be complete, except for incorporation of comments about this submittal.

(b) Implement Interim Design review comments into the drawings and provide annotated comments describing the action taken for each comment (changes or additions to the design, reasons for the design, directions from user, etc.).

(c) Insure that all details, sections, etc., necessary for the final documents have been added to the drawings and are complete and thoroughly cross-referenced.

(d) Complete all schedules. Insure that hardware sets have been added to the door schedule and coordinated with the specifications.

(e) Complete all title blocks including drawing and file numbers, specification numbers, dates, and drawing titles. Information required from the Corps of Engineers shall be requested from the Project Coordination and Specification Section.

(f) Insure that the drawing index is complete, accurate, and coordinated with the drawings and all other disciplines.

9.6.3 Coordination.

All architectural work shall be coordinated with work of other technical disciplines.

(a) Insure adequate above-ceiling space for ductwork, piping, lighting, structural members, etc.

(b) Coordinate reflected ceiling plans with lighting and HVAC plans.

(c) Coordinate light switches with door swings.

(d) Coordinate electrical and mechanical drawings with architectural plans to assure proper power, gas, water, etc. for drinking fountains, kitchen equipment, etc.

(e) Coordinate with other disciplines to insure no there are no conflicts in roof drain, exhaust fan, louvers, and other similar item locations.

(f) Insure that all door louvers are coordinated with mechanical drawings and that no louvers are located in fire or smoke doors.

(g) Insure complete coordination between site work, walks and landscaping, water supply, sewerage, architectural, and electrical.

(h) Coordinate structural with architectural to insure framing at all roof openings.

9.7 READY TO ADVERTISE SUBMITTAL (100%).

(a) Implement Final Design review comments into the drawings.

(b) Verify consistency between plans and specifications.

(c) Verify that all drawings are finalized.

9.8 TECHNICAL REQUIREMENTS.

In addition to the criteria in the following paragraphs, the architectural design shall comply with AEI, Design Criteria, as supplemented by the TM5-800 series. Materials and construction methods shall comply with the instructional notes inserted in the applicable Guide Specifications.

9.8.1 Site Work

9.8.1.1 Floor Relation to Grade.

The finish floor of concrete floor slabs on fill shall be a minimum of 6 inches above the finished grade.

9.8.1.2 Access to Entrances.

All stoops, steps, or similar required access to entrances that will normally be built by a building contractor as differentiated from sidewalks, driveways, etc., which are normally constructed by a paving contractor, shall be shown and detailed on the architectural drawings. Ramps complying with the requirements of ADA and/or UFAS shall be provided where required to allow access by the physically impaired.

9.8.2 Masonry.

9.8.2.1 Interior Walls and Partitions.

Concrete masonry units (CMU) for interior masonry walls and partitions shall be not less than 6 inches in nominal thickness. Where split face units are used, provide smooth face units where concrete paving or flashing occurs and where items are attached to wall surfaces.

9.8.2.2 Coursing.

Concrete masonry unit coursing shall be coordinated with door heights to eliminate the need for cutting block.

9.8.3 Miscellaneous Metals.

All access panels required to service mechanical items normally furnished and installed by the non-mechanical trades shall be shown on the architectural drawings. Insure that access panels, when required, are specified and detailed.

9.8.4 Thermal and Moisture Protection.

9.8.4.1 Roof and Wall Insulation.

Except when required for refrigerated spaces, roof and wall insulation shall be drawn at a nominal thickness consistent with the insulation requirements of the particular building or project. The thickness of roof or wall insulation shall not be dimensional nor the thickness indicated on the drawings. General standards for insulation, as indicated in the applicable guide specification, require insulation thickness as determined by the established "U" value for total roof or wall thickness, and the type of material utilized. Unless specifically directed, "U" values shall be provided as indicated in the AEI, Design Criteria. Details shall allow for possible differences in insulation thickness.

9.8.4.2 Standing Seam Metal Roofs

All standing seam metal roofs shall be installed over a slip-sheet over a 40 mil self-sealing secondary water barrier over rigid insulation board (if attic is to be used as a return air plenum) over a structural metal deck (for diaphragm action).

Roof panels shall be a minimum thickness of 24-gauge steel or 0.040 aluminum. Vented ridge caps are not desirable due to potential leaks. Use locking type seams (as opposed to snaplock type) for hurricane and high wind areas. Roof specifications shall require that an independent registered roofing consultant be present to monitor the entire roof application.

9.8.4.3 Roof Slope.

The minimum roof slope for built-up roofs shall be 1/4-inch per foot, however, the use of a "flat" built-up roof is discouraged except for facilities of unusual building configuration or extremely large areas. In no case shall a built-up roof slope exceed 2 inches per foot. Roof slope for standing seam metal roofs shall be 1:12 minimum, however, individual Installation/Command policy will dictate required slope for a particular base.

9.8.4.4 Sheet Metal.

In all cases sheet metal for various elements used throughout a building shall be of the same basic metal. Atmospheric conditions shall be considered in the selection of exposed sheet metal. Different types of sheet metal that can cause accelerated corrosion (galvanic action) of either one shall not be placed in direct contact. Sheet metal used on roofs with concrete roof tiles shall not react with nor corrode excessively due to the concrete.

9.8.4.5 Gutters and Downspouts.

When downspouts are required they shall not drain directly onto a walk or platform. When downspouts must occur at walks or platforms they shall pass through or under into underground drains or toward open ground beyond. Downspouts draining onto open ground shall be diverted using precast concrete splash blocks to prevent erosion. Use of interior downspouts shall be avoided. The use of scuppers should be maximized. Avoid built-in gutters behind fascia or parapet due to expansion/contraction of metal and surrounding material. All gutters shall have leaf screens.

9.8.5 Doors.

9.8.5.1 Pedestrian Doors.

All pedestrian doors shall be 7 feet 0 inches or 7 feet 2 inches high, except in family housing where they may be 6 feet 8 inches high. Door openings shall, in general, be 3 feet 0 inches wide, except for special purpose doors, toilet rooms (except for handicap) or closet doors in family housing, for instance.

9.8.5.2 Doors to Rooms.

Doors to rooms shall be of adequate size to accommodate the installation and removal of furniture and equipment installed therein.

9.8.5.3 Exterior Doors.

Except in underground structures and floors above the first story of multi-story structures, doors to boiler or mechanical rooms, doors from power rooms, generator rooms, and doors from similar areas should be to the outside of the building only. Electrical closet and air handling room doors may open to the building interior.

9.8.5.4 Special-Purpose Doors.

Special-purpose doors such as rolling and coiling doors shall be adequately designed to safely resist the design wind pressure. Rolling and coiling steel or aluminum doors shall be designed so as to permit operation of the doors at maximum wind velocities defined in the area where used.

9.8.5.5 Finish Hardware.

When selecting finish hardware carefully read the "Notes to Specifier" for the hardware specification Section 08700, Builder's Hardware. Hardware shall then be selected from BHMA and ANSI standards. Except for items not listed by BHMA or ANSI manufacturer names and catalog numbers shall not be used in hardware schedules. All cylinders shall have 7 pins.

9.8.5.6 Hardware Set Designations.

Hardware set designations shall be listed in the Door Schedule in preference to locating on the floor plans. Specification Section 08700, Builder's Hardware, shall provide the necessary hardware set designation numbers, plus description and function of each hardware item included in the Hardware Set.

9.8.5.7 Return Air Louvers.

Overall size of return air louvers located in doors shall be included in the Door Schedule. Minimum bottom rail dimension shall be 10 inches and the minimum stile dimension shall be 5 inches.

9.8.5.8 Door and Window Schedules and Types.

Door and window schedules and types shall be indicated on the contract drawings.

9.8.6 Finishes.

9.8.6.1 Acoustical Plaster and Acoustical Tile.

The use of acoustical plaster is discouraged. In electronics and communications facilities in which avoidance of dust is a major consideration acoustical treatment shall be limited to acoustical tile or gypsum wallboard with non-dusting characteristics.

9.8.7 Rooms and Spaces for Utilities.

Rooms and spaces for utilities, including mechanical and electrical equipment rooms, shafts, chases, and chimneys, shall be indicated on the Concept Design drawings, even though their exact size and location is undeterminable at the Concept Design stage. At times the technical and servicing requirements of the required equipment necessitate increases in the areas allocated in the Concept Design drawings. A reasonable increase in area for utility spaces will be authorized and will specify the extent of increase allowed. If an increase in area cannot be authorized, information shall be furnished by the Corps of Engineers advising which interior areas cannot be authorized and which interior areas must be rearranged or reduced.

9.8.8 Floor Drains and Slopes.

Floor drains and slopes, hose bibbs, and shower heads shall be shown on the architectural drawings as well as on mechanical drawings, and shall be closely coordinated. All floors in areas requiring drains shall be sloped toward the drains.

9.8.9 Lessons Learned

Comply with all Lessons Learned under U.S. Army Corps of Engineers Mobile District home page at www/sam.usace.army.mil.sam/sam/leslrn/cgi-win/llhome.exe.

CHAPTER 10

INTERIOR DESIGN

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EXHIBITS

CHAPTER 10
INTERIOR DESIGN

10.1. GENERAL

10.1.1 OVERVIEW OF MILITARY INTERIOR DESIGN

Military interior design projects are typically classified into two categories: Building related interior design referred to as Structural Interior Design (SID) and furniture related interior design referred to as Comprehensive Interior Design (CID). The two types of projects cover different aspects of the interior environment and are funded through different sources. SID projects are funded with military construction funds. CID projects are funded by the Major Command and/or Installation with operation and maintenance funds.

10.1.2 STRUCTURAL INTERIOR DESIGN (SID)

Completion of a SID involves the selection and sampling of the interior building related finishes. The SID package will include interior floor plans, schedules, and interior finish/color samples. If the Statement of Work (SOW) includes Furniture systems workstations, the SID will include all contract documents and finish samples relating to the workstations.

10.1.3 COMPREHENSIVE INTERIOR DESIGN (CID)

Completion of a CID involves the selection and illustration of the furnishing components used to complete the interior environment. If a CID is indicated by the SOW as a requirement, the CID package will be fully coordinated with the SID throughout all standard design phases and submitted concurrently with the SID package. The CID will included composite furniture floor plans, manufacture's list, furniture placement plans, furniture illustrations sheets, artwork placement plans, artwork illustration sheets, furniture, and artwork cost estimates, order forms, justifications and Unicor waiver requests forms. The CID package may include the furniture systems drawings, specifications, and finish samples if required as part of the CID.

10.1.4 MOBILE DISTRICT INTERIOR DESIGN OBJECTIVES

The Mobile District's goal is to design and construct projects that have successful interiors. To meet our goal, the Mobile District has eight objectives that define a successful interior design package.
They are as follows:

1. Customer satisfaction.

2. Complete coordination between contract drawings and contract specifications.

3. Finishes and furniture selections that meet government procurement regulations.

4. The use of durable, easily maintained finishes that support "good housekeeping" and retain their appearance.

5. Spaces that are planned to support life safety.

6. Spaces that meet the functional needs of the user

7. Furnishing selected that support personal performance and personal health.

Cost constraints can limit creative design efforts. A lack of funds should not be an excuse to diminish designs that create a professional image. When cost constraints exist, there are areas that rank in importance with regards to applied finishes. They are as follows: (1) Entries and Main Conference rooms, (2) Command Areas, (3) Employee Break Room, (4) Toilet Rooms and (5)General Office areas.

10.2 APPLICABLE PUBLICATIONS

Specific publications in this chapter supplement the applicable publications in Chapter 9, titled ARCHITECTURE.

10.2.1 GOVERNMENT PUBLICATIONS

Federal Acquisition Regulations (FAR)

Part 8	Required Sources of Supplies and Services
Part 10	Specifications, Standards and Other Purchase Descriptions

Department of the Air Force
Interior Design Presentation Format

Department of the Army Facilities Standardization Programs
Army Regulation AR 405-70 Utilization of Real Property

U.S. Army Corps of Engineers
ER 1110-345-122 Engineering and Design, Interior Design
DG 1110-3-122 Design Guide for Interiors

10.2.2 REFERENCED STANDARDS

Accessibility
ASTM 117.1 Americans With Disabilities Act Accessibility Guidelines
UFAS Uniform Federal Accessibility Standards

Acoustics
ASTM C 423, PBSC.1 Airborne sound
ASTM C 423-66, PBS C-2 Impact Sound Transmission
SPP Speech Privacy Potential Speech Privacy

Egress
NFPA 101 Fire Safety Code (most current year)
National Building Code, BOCA
Standard Building Code
Uniform Building Code, ICBO

Falls
ASTM D-2047 Test For Slip Resistance of Hard Surfaces

Fire and Flame Spread
ASTM-E-84 Steiner Tunnel Test.
NFAP-701-1 /701-2 Standard method of Fire Test for Flame Resistant Textiles and Films.
NFPA-705 Field flame Test for Textiles and Films
FF 1-70 Standard for the Surface Flammability of Carpet and Rugs (Methenamine Pill Test)
NFPA 80 Fire Test of Door and Windows
NFPA-220 Standard on Types of Building Construction
NFPA 253 Flooring Radiant Panel Test
NFPA-255 Standard Method of Test of Surface Burning Characteristics of Building Materials
NFPA 258 Research Test method for Determining Smoke Generation of Solid Materials.
NFPA 259 Potential Heat of Building Materials
NFPA 260 Methods of Tests and Classification System for Cigarette Ignition Resistance of Components
NFPA 261 Method of Test for Determining Resistance of Mock-up Upholstered Furniture Material Assemblies to Ignition by Smoldering Cigarettes.

NFPA 264 A Standard Test Method of Test for Heat Release Rates for Upholstered Furniture Components or Composites and Mattresses Using an Oxygen Consumption Calometer.

NFPA 265 Standard Methods of Fire Test for Evaluating Room Fire Growth Contribution of Textile Wall Coverings.

NFPA 267 Standard on Mattress, subjected to Open Flame Ignition, Using a Large-Scale Oxygen Consumption Calorimeter.

NFPA 703 Standard for Fire Retardant Impregnated Wood and Fire Retardant Coatings for Building Materials. UL-1056 Fire Test of Upholstered Furniture

CAL TB-133 Flammability Test Procedure For Seating Furniture for Use in Public Occupancies. State of California Bureau Home Furnishings.

CAL-TB 117 (Section A though E) Test Procedures for Testing the Flame Retardance of Resilient Filling Materials used in Upholstered Furniture.

Furnishings

ANSI/ BIFMA X5.6-86 Standard for office Furnishings. (Provide furnishings and equipment with anthropomorphic fit and stability)

Lighting

ANSI E-97 Provide Glare-Free Illumination of work surfaces

ASTM E-97-IES Provide Acceptable Reflectance Level.

10.2.3 TERMS, DEFINITIONS AND RESOURCES

This sections provides a glossary of Federal Government terms, definitions and resources which are useful in understanding and developing the ideas and concepts discussed in this Manual. Within the Department of Defense there are consistent contracting definitions, processes, and actions. However, each Department will use their particular acronym to identify the contracting action. This Glossary will provide the Departments of the Air Force and Army specific acronyms as they relate to the SID/CID packages and related contracting actions.

A-E - ARCHITECT-ENGINEER A term generally used informally to identify a non-government designer, design team or design service contractor.

Air Force Interior Design Presentation Format- A resource indicating the format of SID/CID presentation and additional Air Force Procurement Order Forms. The web site is http://www.afcee.brooks.af.mil/dc/Dcform.htm . Look at Interior Design Program.
Other Air Publication sites are http://afpubs.hq.af.mil/

AR-405-70- Utilization of Real Property- Army space allocation guidance. The Web site is http://www.usapa.army.mil. View “Electronic Publications and Forms”-

Electronic Publications-“Publication in HTML format” the scroll down to AR-405-70.

BCE - BASE CIVIL ENGINEER The Air Force term for the centralized engineering management staff. The BCE is responsible for the coordination of all MILCON and O&M design and construction projects; is the principle coordinator between the designer, users and Major Commands. See also **DPW.**

CBD - COMMERCE BUSINESS DAILY This publication contains the Federal Government's "want ads". It provides advance notice of contracting actions and requests for A-E services.

CID - COMPREHENSIVE INTERIOR DESIGN The selection and illustration of all furniture necessary to complete the interior environment; The submittal is O&M funded and includes furniture illustrations, fabric and finish samples, plans, and ordering information. The CID may include the furniture systems plans and purchase orders if they are not included in the SID. See also **SID.**

DD 1391 - DEPARTMENT OF DEFENSE FORM 1391 A programming document initiated by the installation and submitted to Congress through the Major Command for funding. It includes an outline of basic needs for a proposed facility and an estimated cost to fulfill the needs.

DESIGN BUILD A method of contracting in which a single entity takes responsibility for both design and construction of a facility. Performance requirements are outlined using the RFP format. See also **RFP.**

DPW - DIRECTORATE OF PUBLIC WORKS The Army term for the centralized engineering management staff. The DWP is responsible for the coordination of all MILCON and O&M design and construction projects; is the principle coordinator between the designer, users and Major Commands. See also **BCE.**

ENVIRONMENTAL PRODUCTS GUIDE A GSA catalog for supply items. This guide can be obtained by contacting:

GSA CENTRALIZED MAILING LIST SERVICE (7CAFL)
P.O. BOX 6477
FT. WORTH, TX 76115
(817) 334-5215

FAR - FEDERAL ACQUISITION REGULATIONS The Federal laws governing how the Federal Government buys products and services. FAR 8.4 indicates the process for ordering from Federal Supply Schedules. Title 18 of the U.S. Code allows for direct purchase from UNICOR without competitive bids. FAR 8.6 identifies UNICOR as a mandatory procurement source to all federal agencies for products that meet the requirements of the ordering office. See also **UNICOR.**

FSN 595B - FEDERAL STANDARD NUMBER 595B A collection of standard colors used by the various departments or agencies. The first number in the five digit series indicates a specific finish: (1)full gloss, (2) semigloss and (3)flat. The remaining 4 digits indicate a specific hue and tint/shade range.

FSN 595B - FAN DECK Federal Standard colors are available in a "fan deck" booklet for under $10.00. Use Order number # NSN 7690-01-162-2210 and mail your request and check to:

GSA
Specification Unit (3F-BP-W)
Seventh and D Sts SW
Washington, DC 20407

FSS - FEDERAL SUPPLY SCHEDULES Contracts that provide indefinite quantity contracts for commercial items at established prices for direct ordering use by Government agencies. For copies, mail requests to:

Furniture Commodity Center (3FN-CO)
Crystal Mall 4, RM 403
Washington DC 20406
(703) 305-5056.

FURNITURE SYSTEMS WORKSTATIONS Furniture systems workstations are O&M funded. The designer will coordinate the workstation plans with the building and building systems and provide the plans and specifications in the contact documents for bids if a waiver on workstations has been obtained from Federal Prisons Industries. The General Contractor will purchase and install the workstations and connect the workstations to the building's electrical, data, voice, and LAN systems. Reference Corps Guide Specification 12640 Furniture systems workstations. If a waiver has NOT been obtained from Federal Prisons Industries, then the workstation plans and specifications will be included the CID furniture package. However, workstation layouts are to fully coordinated with the building's systems and workstation layouts are to be included in the contract plans for "information only."

FY - **FISCAL YEAR** (a) October 1 of a calendar year through September 30 of the following calendar year; (b)"FY-...." at the beginning of a project title identifies the year Congress will fund the construction contract.

GSA FSC - GENERAL SERVICES ADMINISTRATION FEDERAL SUPPLY CLASSES
FEDERAL SUPPLY GROUPS Government contracts with private manufacturers that have a fixed price, MOL, and expiration date. This publication can be ordered from the following address:

GSA CENTRALIZED MAILING LIST SERVICE (7CAFL)
P.O. BOX 6477
FT. WORTH, TX 76115
(817) 334-5215

The Web site is: www.gsa.gov

IFB - INVITATION FOR BID One of the ways the Government solicits for construction. The IFB is a standard contract with clearly defined requirements, specifications, and terms that are not negotiated. Any proposal prepared in response to an IFB must strictly adhered to the terms. The award is based on the lowest bid meeting the requirements and specifications. See also RFP.

JOC - (JOB ORDER CONTRACT) OR SABER (SIMPLIFIED ACQUISITION OF BASE ENGINEERING REQUIREMENTS) The JOC (Army) and SABER (Air Force) are methods the installation uses to contract for repair work. The Contracting Officer and the contractor agreed upon unit prices for work, then individual job orders are negotiated for specific scopes of repair work.

MILCON - MILITARY CONSTRUCTION Funds that are appropriated by Congress for new military construction.

MOL - MAXIMUM ORDER LIMITATION The limit on the amount that can be purchased from a given vendor under GSA Federal Supply Class/General Supply Group contracts.

OMA-O&M - OPERATION AND MAINTENANCE Funds provided to each installation by the Major Command and used for the day to day operations of the installation. These funds may be used for the renovation of existing buildings or for the purchase of furniture. Funds not spent to award a contract disappear at the end of the FY and cannot be recovered.

OPEN MARKET - Designation for products that are not on a GSA or UNICOR contract.

RFP - REQUEST FOR PROPOSAL One of the ways the Government solicits for construction. An RFP usually defines a design problem and allows those who respond to the RFP to suggest a solution. The RFP is much more flexible than the **IFB.**

RFQ - REQUEST FOR QUOTES An informal request for a price for a standard item.

SF 254 & 255 - STANDARD FORMS A-E resume forms that state the qualifications of A-E firms responding to a CBD announcement. See also **CBD**.

SID - STRUCTURAL INTERIOR DESIGN (a) The selection and sampling of building related finishes; (b) A submittal with samples of proposed building materials a for a particular project; (c) Materials and finishes purchased and installed by the General Contractor; (d) Projects that are funded with the MILCON funds. The SID may also include the O&M funded furniture systems workstations if a waiver has been obtained from Federal Prison Industries.

UNICOR The trade name for the Federal Prison Industries (FPI)Inc., a wholly owned government corporation established in 1934. UNICOR provides a variety of products and services to the Federal Government. All furniture systems workstations and conventional furniture requires a waiver. All waivers are to be requested at 35% design. Web site for FPI is www.unicor.gov. The waiver requests are sent to FPI on this web site.

10.3 PROJECT DEFINITION (10-15%)

10.3.1 STRUCTURAL INTERIOR DESIGN NARRATIVE

Provide a narrative that discusses the basic design objectives for the facility. Discuss the building's materials, finishes, and colors with regards to aesthetics, maintenance, durability, life safety, image and cost. State any specific materials, finishes and colors that are required by the Installation Design Guide. See Chapter 9 titled Architecture.

10.3.2 COMPREHENSIVE INTERIOR DEISGN NARRATIVE

Provide a narrative that discusses the basic design objectives for the furnishings being considered for the facility. State any specific requirements of materials, finishes, and colors. Discuss the furnishing selection with regards to the SID. The narrative is to include but is not limited to CID aesthetics, form, function, maintenance, durability, life safety, and cost. Indicate that Government procurement regulations are being consider in the design development process. Provide information on what items will go to FPI and what items are being considered GSA or open Market.

10.4 CONCEPT DESIGN (30-35%)

10.4.1 SID

Provide items listed in Exhibit 10-1 for this design phase.

10.4.2 CID

Provide items listed in Exhibit 10-2 for this design phase.

10.5 INTERIM DESIGN (50-60%)

10.5.1 SID

Provide items listed in Exhibit 10-1 for this design phase.

10.5.2 CID

Provide items listed in Exhibit 10-2 for this design phase.

10.6 FINAL DESIGN (UNREVIEWED 100%)

10.6.1 SID

Provide items listed in Exhibit 10-1 for this design phase.

10.6.2 CID

Provide items listed in Exhibit 10-2 for this design phase.

10.7 READY TO ADVERTISE 100%

10.7.1 SID

Verify that all items listed in Exhibit 10-1 are incorporated.

10.7.2 CID

Verify that all items listed in Exhibit 10-2 are incorporated.

10.8. TECHNICAL AND ASSEMBLY REQUIREMENTS FOR SID/CID BINDERS

10.8.1. GENERAL INSTRUCTIONS

(a) CONTRACT DOCUMENTS: The designers shall not reference the SID/CID binders in the drawings and specifications. The SID/CID binders are only used as presentation tools during the design process to illustrate color, texture, and pattern. The general contractor will only see the SID/CID binders after the project has been awarded.

(b) FEDERAL STANDARD 595B COLORS (FSN 595B): Using the Federal Standard Colors 595B is required when indicating exterior colors. The use of Federal Standard Colors is not required when indicating interior colors. EXCEPTION: Hurlburt Field, FL requires both exterior and interior paint colors to be indicated with the FSN 595B code. It is suggested that a generic color name also accompany the 595B color number.

(c) DISCLAIMER: Guide Specification 09915 Exterior/Interior Color Schedule indicates that all product trade names and colors used for the project are proprietary. When this guide specification is used it is not necessary to place the disclaimer on the contract drawings.

(d) SIGNAGE: Signage is critical to "pathway finding" and must met the requirements indicated in the Americans With Disabilities Act unless directed otherwise, by the SOW.

(e) ACCESSIBILITY: All designs, including workstation and signage, must comply with the Americans with Disabilities Act (ADA) or the Uniform Federal Accessibility Standards (UFAS), whichever is the most stringent. The only exceptions to this requirement are facilities which limit their access to able bodied military personnel in accordance with the exclusion in Paragraph 4.1.4 of UFAS.

(f) SPECIAL REQUIREMENTS: The designer shall identify items in the CID that require attachment to the building either by cutting or fitting. The designer must prepare and provide specifications and drawings for this service to be performed.

(g) CID FURNITURE RESOURC**E**: Furniture may be obtained from three categories of sources: UNICOR, GSA Federal Supply Schedule (GSA/FSS), and open market. Every effort should be made to use UNICOR, GSA Stock, or Federal Supply Schedule items. However, when the Designer determines CID items are not available on FSS/GSA contract or UNICOR, a letter of justification to purchase an open market source is required. The designer shall write the justification letter. This letter shall be included in the CID Binder and attached to the required Order Form. The designers are required to write a specification for bidding purposes for CID items that require a formal solicitation.

(h) ENVIRONMENTAL QUALITY: Designers should be aware and consider providing building finishes, materials, and furniture that support the Federal Government's efforts to building "Green Buildings". Incorporate of the principles of the Environmental Protection Agency's Green Lights Program must be included in the design process. Designers are to select and specify furniture that includes ergonomic features designed for anthropomorphic fit and stability.

(i) HEALTH, SAFETY, AND WELFARE: Fire safety is one of the paramount concerns in any design. Designers must comply with the appropriate fire safety code for not only egress but also for building and furniture materials, finishes, and fabric selections and applications. Designers are also to consider these same items to protect against falls, levels of emissions from products, and microbial conditions which affect indoor air quality.

(J) FPI REQUEST FOR WAIVER: Each and every furniture item not ordered from FPI is to have a “Request for Waiver” sent to FPI using the FPI worldwide web site. The agencies submitting the waivers will be determined in a future addendum. All workstations purchased by the general contractor is to have the approved FPI Request for Waiver Reference number indicated in the contract bid documents.

10.8.2 PRESENTATION FORMAT

(a) SID and CID information and samples are to be submitted in 3 ring binder(s); 210 x 280 mm (8 1/2” x 11”) format with a maximum spread of 640 mm (25 1/2") for foldouts.

(b) Each SID/CID binder shall be labeled on the outside spine and front cover with the following information:

Design Phase,	Volume number (i.e.: Vol 1 of 3).
Structural or Comprehensive Interior Design	
Project Title	Project Location
Date	Design Agent or Firm

(c) Each sheet within the binder shall be labeled with the project title, project location and design agent or firm.

(d) Color boards are to be sturdy enough to support and anchor all samples. Anchor large or heavy samples with mechanical fasteners or Velcro rather that rubber cement or glue.

(e) SID finish samples shall be organized, grouped, and illustrated by Color Placement Zones. A Color Placement zone is all the spaces/areas within a building that have like finishes. For example, all toilet rooms might have the same color scheme and would then comprise a color placement zone. The general office areas might have another color scheme and would then comprise another color placement zone. If a finish is used in more than one zone, it may be sampled only in the first color scheme where it appears, and may then be referenced with a note on subsequent color schemes.

(f) Label all samples with the same code used in the drawing and specifications.

(g) Material and finish samples must indicate true pattern, color, and texture. Carpet and fabric samples must be large enough to indicate a complete pattern or design.

(h) Photographs or colored photocopies of building materials and furniture finishes will be disapproved. Colored photocopies of artwork and plants are acceptable.

(i) Each sample board is to be inserted into a clear page protector that is sturdy enough to keep the pages from tearing out.

(j) See Exhibit 10-1 and 10-2 for the sequence of SID/CID submittals.

10.8.3 REVIEWS AND REVISIONS

All SID and CID packages will be reviewed by the Government during each design phase of the project. Written annotated comments will be provided to the designer. These review comments, along with the designer's written responses should be placed in the front inside pocket of the first volume of the next SID or CID binder submittal. The designer should revise the binder after each review to respond to the review comments. Printed information on existing SID/CID pages may be revised with white-out. If the binders are not returned to the designer after the design review, the designer shall provide updated inserts to the Government.

10.8.4 DRAWINGS AND ILLUSTRATIONS REQUIREMENTS FOR SID/CID

(a) CONTRACT DRAWINGS: The Mobile District has designated Contract Sheet letter **"I"** for interior design related drawings (Reference DOD TRI-SERVICES CADD STANDARDS). Interior design related drawings are typically the material, finish, and color schedules, furniture systems workstation plans, signage plans and schedules, and additional plans that define and illustrate design and furniture details that relate to the construction of the facility. CID furniture placement plans may also be required to appear in the contract drawings for information only. If required, these sheets shall be indicated on **"I"** drawings. Interior designers and interdisciplinary teams of architecture and engineering shall coordinate drawings to insure SID/CID information appears on and coordinates with sheets related to other design disciplines.

(b) SPECIFICATIONS: The interior designers shall coordinate and co-edit guide specifications involving interdisciplinary teams of architecture, electrical, and mechanical engineering to insure a fully coordinated SID and CID package.

(c) RENDERINGS & SKETCHES: Renderings and black & white sketches may be required for some interior design projects. Verify that renderings and/or sketches are required by the SOW. All renderings and sketches are to be professional in appearance. The designer is to submit a sample of the proposed artistic style to be used for Government approval. Some installations have standard framing and matting requirements that the designer must comply with when submitting a rendering. The rendering and sketches are to emphasize spatial relationship, furnishings, patterns, and texture. The Government shall select the areas that a final rendering(s)will illustrate.

(d) Composite Floor Plans: The composite floor plan(s) are full size contract drawings that show all panels, components and conventional furniture in relationship to the building and the building's systems. This includes information on locations of light switches, fire pull boxes and mechanical devices. All furniture items are to be numbered with a code and coordinated with CID order forms. Half size drawings will not be accepted for review. Plan room numbers are to appear on the drawings.

(e) Panel Plans (for Furniture systems workstations): The Panel plans should include a panel symbol legend, panel placement, critical dimensions of aisle widths, and critical dimensions tying the panels to the building's communication, electrical and mechanical systems. **Panels must not block access to mechanical, electrical switches and fire controls.** Each panel should be coded with a system such as the following:

N (non-powered) **Width**(in centimeters) **Height**(in centimeters)
P (powered)

For example, a non-powered panel 610 mm(2 feet) and (1727 mm) (five feet eight inches) tall would be noted on the panel plan as **N 61 172.7**.

(f) Electrical, Voice, and Data Plans: The Furniture systems workstations Electrical, Voice and Data plans should show panel placements, all receptacles used in each workstation, height and location of all light switches, mechanical control devices, and a symbol legend. Include a general note that states "The Electrical, Voice, and Data Plans shall to be coordinated with the building’s Communication, Electrical, and Mechanical Engineering Drawings and Specifications."

(g) Furniture Systems Basis for Design: Furniture systems workstations should be designed using generic components and work surfaces sold by many manufacturers. Use one manufacturer as a basis for design, and indicate that manufacturer's name and finishes in Guide Specification 09915 Exterior/Interior Color Guide Schedule. Indicate fabric construction, fiber content, and width in Guide Specification 12640 Furniture systems workstations. NO COM (customers own materials) is to be used. No wall mounted components are to be used. If a waiver for workstations has not been obtained from FPI the basis for design should be FPI.

(h) Workstation Types and Number Codes: The workstations should be classified into groups of like configuration and features, and each group or type should be given a single letter code (A, B etc.) For example, all similar reception stations might be type "A" and all technician offices might be type "B". Each workstation should also be given a unique number code similar to a room number but separate from the building room number system. Every workstation should be identified on every plan with the composite code composed of the letter identifying the type and the workstation number code. For example "A110" would indicate that workstation number 110 is a type A.

(i) Workstation Elevation and Inventory Drawings: The Workstation Elevation and Inventory drawings should show an elevation of each type of workstation with a related inventory list of all panels and components used. The inventory list should describe components generically rather than using specific part numbers.

(j) Workstation Finishes: It is suggested that only two fabrics be used for workstations: one color for panels and one for tackboards. No fabric is to be used on the flipper doors. A third color may be used to unify workstations used by the same organizational group or for path wayfinding. It should be noted that some installations have color and finish restrictions. The designers shall comply with local standards.

(k) Workstation Costs: The average cost of a workstation is $4,500.00. If the cost exceeds this figure, the project will be rejected. The total cost available for funding furniture systems for a project is listed as a non-add entry in block 9 of the DD Form 1391. In block 12b, list the equipment as an O&M funded item, the fiscal year the funds are requested and the line item cost.

(l) Workstation Components: The following items are typical workstation components and options to be selected and specified.

PANELS/FRAMES and TILES
Acoustical/nonacoustical
Powered/Nonpowered
Tool Bar Tiles

COMPONENTS

ACCESSORIES

Worksurfaces	Tackboards
Drawers	Locks
Shelves (with doors/without)	Shelf Dividers
Files(mounted to worksurface or panel hung)	Paper flow devices
	Marker boards
Task light/special purpose	Coat Hooks
Counter Tops	Keyboard trays
Wire Management	Mouse Pads
Connecting Hardware	Wrist rest/Foot Rest

<u>SIGNAGE</u>
Organizational signs and workstation name/number signs

(m) Manufacture's Summary List: The Manufacturer Summary List is a list of all the manufacturers whose products are used in the CID package. For each manufacturer, provide the name, address, phone and fax number and a point of contact.

(n) Furniture Placement Plan: A Furniture Placement Plan (FPP) is a plan of one room showing each furniture component in the room. There will be one FPP for each room on the Composite Floor Plan. FPP's are drawn to 1:50 (1/4" = 1'-0") if possible or a 1:100 (1/8" scale)if the room or area illustrated is very large. Each FPP should include the following:

Job name	Job location
Footprint of the room	Coded furnishings
Room name and number	Scale

(o) Furniture Illustration Sheets: Provide one Furniture Illustration Sheet for each item of furniture. Each item shall be given an item code for simple identification purposes. The item code system is to begin with 001. Furniture Illustration sheets should be arranged in numerical order by furnishing item number. The furniture Illustration Sheet should include all of the following information.

Job name　　Job location
A picture or line drawings of the product specified
The furnishing item code number to key the product to the plans
The options specified, if any
Samples of the finishes and fabrics

(p) Artwork Placement Plans: An Artwork Plan is a full size drawing indicating the location for all artwork. The plan shall detail secure hung pieces, the height of all pieces, and the horizontal location within the space. Artwork Illustration Sheets are identical to Furniture Illustration Sheets. The Artwork package is to be separate from the furniture package due to the fact that the entire artwork package can be bid as a whole unit complete with installation. This is not typical of furniture packages. Artwork Placement Plans are drawn at 1:50(1/4”=1’-0”) if possible or at 1:100 (1/8”=1’0”). The artwork illustration sheets should include the same project specific and room specific information as the furniture Illustration Sheets.

(q) Itemized Furniture Cost Estimate: The itemized furniture cost estimate lists all furnishing grouped according to UNICOR and GSA/FSC Group, Part, and Section of the FSC schedules. The cost estimate should also include 10% for contingency, 7-9% installations, and 7% service fees. Estimated freight charges that are not included in furniture cost should also be a separate line item.

(r) Furniture Order Forms: The Furniture Order Forms provide all information necessary to order the furnishings specified in the CID. Only one item should be listed per order form. The forms should be in numerical order according to the item furniture code starting with 001. The Furniture Order Form should include the following information:

- Furnishing item number.
- The project name, location
- FSC Group, part and section
- GSA contract number, special item number and contract expiration date
- Source and manufacturer's name(including ordering address, telephone numbers, fax numbers and Point of Contact.
- Product name.
- Product model number or National Stock Number.
- Finish name and number.
- Fabric name and number.
- Dimensions.
- Weight(if available)
- Description (include construction information, fabric content,)
- Justification(Example: These guest chairs are coordinated to match the task seating location code 001. The scale of the guest chair is critical due to the limited space available at each workstation where they are used. If this chair is not purchased, coordinate the newly selected chair with finishes for item number coded 009, 001 and 113.
- Item placement by room number.
- quantity per room.
- Unit price.
- Total price.
- Special instruction.

FPI approved waiver identification number is applicable.

Note: Some MAJCOMs require that the A-E fill out the government purchase request in lieu of the Procurement Information Sheet. Verify which method is preferred. Items will be purchased using one of two different forms: DD Form 1348-6 or AF Form 9.

10.8.5 CID FURNISHINGS AND FURNITURE COST GUIDELINES

10.8.5.1 CID FURNISHINGS

ADP tables/printer stands
Acoustical partial height partitions 6' of less in height - freestanding
Artwork
Beds/wall units/ night stands/ chests/ refrigerators
Bedspreads/bedding
Bookcases
Bulletin board/ projection screens (If **NOT** attached to structure.)
Carts
Chairs - all kinds, including stools
Desks - freestanding
Drafting tables
Draperies
Files - all kinds
Library furniture - book stacks/card files/ study carrels
Modular desk units
Podium/ lecture stands
Furniture systems workstations (If not in SID)
Planters/art/waste & ash receptacles
Storage - all kinds
Tables - all kinds
Upholstered lounge seating (sofas, etc.)
Wardrobes (if not included in construction contract)

10.8.5.2 FURNISHINGS COST GUIDELINES

The following 1995 furniture cost guidelines are to be used as planning factors to develop actual budgets for the CID. The information is based on both Army and Air Force design cost guidelines. The information is first given as a cost per square foot for several types of facilities; then as cost per unit for several types of facilities. The information does not include 25% associated costs such as contractor's overhead, profit, shipping, storage or management services associated with these activities. An inflation factor of 2.5% per year should be included for subsequent years. Costs are based on continental United States usage and must be used in conjunction with experience factors for specific overseas locations.

FACILITY TYPE

	COST/SQ/FT	COST/SQ METER
Administration Space, (Conventional Standard)	**$8-$14.00**	**$86.00**
Administration Space, (Conventional Executive)	**$15-$20.00**	**$161.00**
Administration Space, Furniture systems workstations	**$43.00**	**$ 443.00**
Airmen Club (excluding kitchen equipment)	**$13.00**	**$140.00**
Alert Facilities	**$13.00**	**$140.00**
Auditorium (fixed seating)	**$35.00**	**$377.00**
Base Ops DV Lounge	**$20.00**	**$20.00**
Chapel	**$26.00**	**$280.00**
Chapel, Family Life Center	**$14.00**	**$150.00**
Child Development Center	**$14.00**	**$150.00**
Classroom	**$14.00**	**$150.00**
Clinic/Dental Clinic (excluding equipment)	**$16.00**	**$172.00**
Conference Room (Standard)	**$20.00**	**$215.00**
Conference Room (Executive)	**$54.00**	**$581.00**
Dining Facility (excluding kitchen equipment)	**$34-45.00**	**$377.00-484.00**

Open Mess Facilities (excluding equipment)	$30.00-35.00	$323.00-377.00
Distinguished Visitor's Suite (in Lodging)	$30.00	$323.00
Family Housing Office	$16.00	$172.00
Fire Station	$13.00	$140.00
Golf Clubhouse	$15.00	$161.00
Judge Advocate Facility (including Courtroom)	$25.00	$269.00
Library	$25.00	$269.00
Lodging Office	$15.00	$161.00
Physical Fitness Center (excluding equipment)	$12.00	$129.00
Recreation Center	$12.00	$129.00
Temporary Lodging Facility (TLF)	$16.00	$172.00
Training Center (Miscellaneous types)	$14.00	$151.00
Unaccompanied Officer Personnel Housing (UOPH)	$20.00	$215.00
Unaccompanied Enlisted Personnel Housing (UEPH)	$18.00	$194.00

Visiting Airmen's Quarter (VAQ Single Occupancy)	$17.00	$183.00
Visiting Airmen's Quarter (VOQ)	$17.00	$183.00
Youth Center	$13.00	$140.00
FACILITY TYPE COST PER UNIT	COST/UNIT SQ FT	NOT USED
Administration Space (furniture systems workstations per workstation: includes installation and egro chair	$4,500.00	NOT USED
Lodging Office/Lobby • without front desk • with front desk	 $15K to 20K $40K to 100K	NOT USED
Distinguished Visitor Suites • One bedroom suite • Two bedroom suite • 2 to 3 bedroom apartment (including dining room)	 $15K to 20K $25K to 36K $40K to 45K	NOT USED
Temporary Living Facility	$17.5K	
Unaccompanied Enlisted Personnel Housing (UEPH) (per		

person)	**$4.5K**	
Unaccompanied Officers Personnel Housing (UOPH) • **Bedroom only** • **Small apartment**	 **$7K** **$9K-10K**	
Visiting Airmen Quarters (VAQ) • **Single room** • **Single Suite** • **Double Suite**	 **$8K** **$10K** **$15K**	

**** K-indicates thousands.***

10.9 LESSONS LEARNED

10.9.1 Interior Floor Finishes

10.9.1.1 Flooring in administrative offices within industrial/shop and warehouse space should be a medium value, vinyl composition tile. Carpeting has been proven to be a maintenance problem in these areas.

10.9.2 Interior Base Finishes

10.9.2.1 Provide rubber base with pre-formed outside corners in high traffic areas.

10.9.3 Interior Wall Finishes

10.9.4 Interior Ceiling Finishes

10.9.5 Interior Trim

10.9.6 Interior Window Treatments

10.9.7 Interior Miscellaneous

10.9.7.1 SOLID SURFACE MATERIALS-Provide 12.50 mm (1/2”) solid surface material on horizontal surfaces. Provide 6.25 mm (1/4”) solid surface material on vertical surfaces. Any thickness greater than 12.50 mm (1/2”) specified is considered excessive.

10.9.8 Interior Signage

10.9.9 Furniture-Systems and Conventional

10.9.9.1 Avoid solid colored fabrics for seating. Specify tweeds and small patterns for seating fabrics to reduce the appearance of soil, dust and dirt.

Exhibit 10-1 gives information on the SID sequence of assembly and indicates what information must be included in each design phase. Note that SID and CID Interior Design Submittals run concurrent with the Architectural Submittals.

If the client is installing the furniture systems workstations, all furniture systems workstations should be indicated in the contract drawings with the note "FOR INFORMATION ONLY". The CID shall then included items 12-16 of the SID Matrix Summary.

SID Submittal Matrix Summary EXHIBIT 10-1

(Use Metric scale when required)

ITEM	DESCRIPTION	10%-15%	30%-35%	50%-60%	100%	RTA
1.	TITLE PAGE NOTE TO THE REVIEWER RETURN ADDRESS OF DESIGNER		X X X	X X X	X X X	X X
2.	TABLE OF CONTENTS (SID)		X	X	X	X
3.	NARRATIVE of SID OBJECTIVES	X	X	X	X	X
4.	COLOR PLACEMENT ZONE PLANS		X	X	X	X
5.	INTERIOR COLOR BOARDS (related to "zones")		X	X	X	X
6.	INTERIOR SIGNAGE SAMPLES		X	X	X	X
7.	PREWIRED WORKSTATION COLOR BOARDS		X	X	X	X
8.	DRAWINGS-INTERIOR FLOOR PLANS (contract drawing)		X	X	X	X
9.	MATERIAL, FINISH AND COLOR SCHEDULE (contract drawing)		X	X	X	X
10.	CEGS 09915 COLOR SCHEDULE		X	X	X	X
11.	SIGNAGE PLANS AND/OR SCHEDULES (contract drawings or CEGS 10440)				X	X
12.	WORKSTATION COMPOSITE FLOOR PLANS (contract drawings)		X	X	X	X
13.	WORKSTATION PANEL PLANS (contract drawings)			X	X	X
14.	WORKSTATION ELECTRICAL/VOICE/DATA PLANS (contract drawings)			X	X	X

15.	WORKSTATION ELEVATIONS AND INVENTORY DRAWINGS			X	X	X
16.	WORKSTATION COST ESTIMATE		X	X		

Exhibit 10-2 2 gives information on the CID sequence of assembly and indicates what information must be included in each design phase. Note that SID and CID Interior Design Submittals run concurrent with the Architectural Submittals.

If the client is installing the furniture systems workstations, all furniture systems workstations shall be indicated in the contract drawings with the note "FOR INFORMATION ONLY". The CID shall then included items 12-16 of the SID Matrix Summary.

EXHIBIT 10-2- CID Submittal Matrix Summary

ITEM	DESCRIPTION	10%-15%	30%-35%	50%-60%	100%	RTA
1	TITLE PAGE NOTE TO THE REVIEWER RETURN ADDRESS OF DESIGNER		X X X	X X X	X X X	X X
2.	TABLE OF CONTENTS		X	X	X	X
3.	NARRATIVE OF CID OBJECTIVE	X	X	X	X	X
4.	PROPOSED RENDERING TECHNIQUE		X			
4.A	PHOTO OF APPROVED INTERIOR RENDERING (only if required by contract)				X	X
5.	BLACK & WHITE SKETCH PERSPECTIVE(s) (only if required by contract). One will be approved for the interior rendering		X	X		
6.	COMPOSITE FURNITURE PLANS WITH CONVENTIONAL AND FURNITURE SYSTEMS WORKSTATIONS (full size drawings)		X	X	X	X
7.	FURNITURE SYSTEMS WORKSTATIONS PANEL PLANS (Only if client is buying and installing furniture systems workstations)			X	X	X
8.	FURNITURE SYSTEMS WORKSTATIONS ELECTRICAL /VOICE/DATA PLANS (Only if client is buying and			X	X	X

	installing furniture systems workstations)					
9.	FURNITURE SYSTEMS WORKSTATIONS ELEVATION AND INVENTORY DRAWINGS (Only if client is buying and installing furniture systems workstations)			X	X	X
10.	MANUFACTURER'S SUMMARY LIST				X	

EXHIBITS 10-2 CON'T CID FURNITURE REQUIREMENTS

11	CONVENTIONAL FURNITURE PLACEMENT PLANS (individual rooms)			X	X	X
12	CONVENTIONAL FURNITURE ILLUSTRATION SHEET (sample sheet only)		X			
12A.	CONVENTIONAL FURNITURE ILLUSTRATION SHEET all rooms			X	X	X
13.	ARTWORK PLACEMENT PLAN			X	X	X
14.	ARTWORK SPECIFICATION SHEETS			X	X	X
15.	ITEMIZED FURNITURE COST ESTIMATE			X	X	X
16.	INTERIOR FURNISHINGS ORDER FORMS (sample only)		X			
16.A	INTERIOR FURNISHINGS ORDER FORMS (all items)			X	X	X
17.	LETTERS OF JUSTIFICATION FOR WAIVERS (if required)			X	X	X

EXHIBIT 10-3 FINISH SCHEDULE

MATERIAL (MAT.), FINISH (FIN.) AND COLOR (COL.) SCHEDULE

ROOM NO.	ROOM NAME	FINISH FLOOR		BASE		WAINSCOT		HEIGHT	NORTH WALL			SOUTH WALL			EAST WALL			WEST WALL			CEILING		HEIGHT	REMARKS
		MAT.	FIN. & COL.	MAT.	FIN & COL.	MAT.	FIN. & COL.	WAI	MAT.	FIN. & COL.	CHAIR RAIL	MAT.	FIN & COL.	CHAIR RAIL	MAT.	FIN. & COL.	CHAIR RAIL	MAT.	FIN. & COL.	CHAIR RAIL	MAT.	FIN & COL.	0'-0"	

MATERIAL (MAT.), FINISH (FIN.) AND COLOR (COL.) LEGEND SEE SPECIFICATION 09915 COLOR SCHEDULE FOR MORE DETAIL INFORMATION ON EXTERIOR AND INTERIOR COLOR, FINISH AND MANUFACTURER

MARK	FINISH FLOOR MATERIAL	MARK	FINISH FLOOR FINISH & COLOR	MARK	WALL BASE FINISH & COLOR	MARK	WALL FINISH & COLOR	MARK	CEILING FINISH & COLOR
CONC		CP1-1	CARPET					P-1	PAINTED, EGGSHELL FINISH
		CP1-2	CARPET TILE					ATC-1	ACOUSTICAL CEILING TILE
MARK	BASE/ WALL MATERIAL	CP1-3	CARPET TILE	PT-4	PORCELAIN TILE	P-2	PAINTED, EGGSHELL FINISH	-	UNFINISHED
GWB	GYPSUM WALL BOARD	CP1-4	CARPET TILE	PT-5	PORCELAIN TILE	AO-1	ARCHITECTURAL ORNAMENT	EXP	EXPOSED
EXC	EXPOSED CONCRETE	PT-1	PORCELAIN TILE	RB-1	RUBBER BASE				
CMU	EXPOSED CONC. MASONRY	PT-2	PORCELAIN TILE	RB-2	RUBBER BASE				
CM	CULTURED MARBLE	PT-3	PORCELAIN TILE						
MARK	CEILING MATERIAL								
EXP	EXPOSED								
GWB	GYPSUM WALL BOARD	SV-1	SHEET VINYL						
ACT	ACOUSTICAL CEILING TILE	SC	SEALED CONC. (CLEAR)						

EXHIBIT 10-4 ITEMIZED FURNITURE COST EXTIMATE

SOURCE: FSC GROUP 71, PART III, SECTION X CONFERENCE TABLES

ITEM NO.	MANUFACTURER	DESCRIPTION	QTY.	UNIT PRICE		TOTAL
(EDIT) 00X						
00X.						
00X						
00X						
00X						
00X						
00X						
						SUB TOTAL

SOURCE: FSC GROUP 71, PART III, SECTION L

ITEM NO.	MANUFACTURER	DESCRIPTION	QTY.	UNIT PRICE		TOTAL
00X						
00X.						
00X						
00X						
00X						
00X						
00X						
						SUB TOTAL

ALL FSC GROUPS

SUB TOTAL:
10% CONTINGENCY:
FREIGHT:
MISC FEES:

GRAND TOTAL:

<u>EXHIBIT 10-5 OPEN MARKET OR SOLE SOURCE JUSTIFICATION FORMAT</u>

<u>LETTER OF JUSTIFICATION</u>

1. DATE:

2. REQUESTING ACTIVITY:

3. POINT OF CONTACT:

4. REQUIREMENTS:

4. CURRENT SITUATION:

5. PROPOSED SOLUTION:

6. TANGIBLE/INTANGIBLE BENEFITS:

7. IMPACT IF REQUEST IS NOT APPROVED

8. ESTIMATED DATE REQUIRED

9. UNICOR WAIVER STATUS

10. COMPETITIVE BID REQUIREMENTS

11. OTHER SOURCES REVIEWED AND THE JUSTIFICATION FOR NOT SELECTING THOSE SOURCES

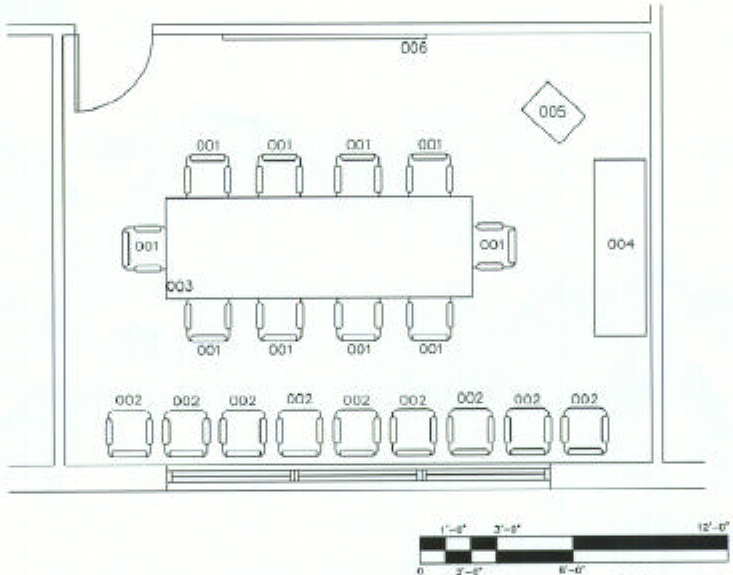
EXHIBIT 10-6 AR-405-70 NET SPACE UTILIZATION GUIDANCE

SPACE ALLOCATION	**GRADE**	NET SQUARE FOOTAGE ALLOWANCE
P-1 Commanders and Deputy Commanders Heads and Deputies of Directorates, Offices, Bureau, and Agencies	010 & 09 010, 109 and GS/GM 18 Comparable positions	400
P-2 Command and Deputy/Assist Cos Heads and Deputies of Directories	08 & 07, SES, GS-15	300
P-3 Commands and Deputy Commanders Commanders Division Heads Branch Heads Professional/Admin. Personnel Command Sergeants Major of Positions in P-1 and P-2 Categories	06 05 GS 15-14 Colonel GS 15-14 Colonel GS 16	200
P-4 Commanders Division Heads, LT. Cool Branch Heads Command Sergeants Major of Positions in P-3 Category	04 GS13 GS 15-13	150
P-5 Commanders Branch Heads Professional/Admin. Personnel Staff Sergeants Major Unit First Sergeant	03 GS 12, Major GS 13, LT. Col. & below who require office E-8	110
CIVILIAN PERSONNEL /CIVILIAN SPECIFIC CATEGORIES 0-1 Unit Supervisors	GS-9, E-8 WO, 01 or above W/6 Employees	110
0-2 Professional Administrative Personnel Unit Supervisors	GS-7, E-8 WO, 01 and above GS-8, E-7 and above	100
0-3 Clerical *	GS-07-GS-14	110
Employees (Non-Supervisory)	GS-07-GM-14	110
Administrative Officers (Non-Supervisory)	GS-12	110
Employee (Special assignment)	GS-12	160 plus dimension of all equipment + 50%
Supervisor	GS-13	150
Supervisor	GS-14	200
* NOTE: Add five (5) square feet for computer terminals, fax machines printers, typewriters etc.		

AR REG 405-70 15 Sep 93

NOTE: FOR AIR FORCE PROJECTS USE:
AIR FORCE HANDBOOK 32-1084 "STANDARD FACILITY REQUIREMENTS HANDBOOK"
CHAPTER 12- CATEGORY GROUP 61- ADMINISTRATIVE FACILITES

EXHIBIT 10-7 FURNITURE PLACEMENT PLANS



ROOM: (ENTER ROOM NAME & NUMBER HERE) SCALE: 1/4" = 1'-0"

ITEM NUMBER	DESCRIPTION	QUANTITY
001	CONFERENCE CHAIRS, (SUPPLY MANUFACTURER'S NAME & STYLE NO.)	[illegible]
002	GUEST CHAIRS, (SUPPLY MANUFACTURER'S NAME & STYLE NO.)	9
003	CONFERENCE TABLE, (SUPPLY MANUFACTURER'S NAME & STYLE NO.)	[illegible]
004	CREDENZA, (SUPPLY MANUFACTURER'S NAME & STYLE NO.)	1
005	PODIUM, (SUPPLY MANUFACTURER'S NAME & STYLE NO.)	1
006	VISUAL BOARD, (SUPPLY MANUFACTURER'S NAME & STYLE NO.)	1

FIRM NAME	FURNITURE PLACEMENT PLAN	PROJECT NAME
FIRM NAME	PHASE PERCENT	PROJECT NAME
DATE		PROJECT LOCATION
		CONTRACT NUMBER
		PAGE C-1

EXHIBIT 10-8 FURNITURE ILLUSTRATION SHEET

FURNISHING ITEM:__________ ITEM NUMBER:________

FABRIC
(Fabric Name)
(Fabric Number) (Place sample here)

FINISH
(Finish Name) (Place sample here)
(Finish Number)

(Place photograph here)

OPTIONS (if any)

____
____
____
____
____
____

ROOM	QUANTITY
(Enter Room number and name)	_____
(Enter Room number and name)	_____
(Enter Room number and name)	_____

Firm Name
Firm Name
Date

FURNITURE ILLUSTRATION SHEET
_____% **Submittal**

Project Name
Project Address
Contract No.__________

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CHAPTER 11

STRUCTURAL

INDEX

CHAPTER 11

STRUCTURAL

11.1 GENERAL.

11.1.1 Scope.

This chapter states criteria, requirements, and guidance for structural design. Specific submittal requirements in this chapter supplement the requirements of Chapter 1, titled GENERAL INSTRUCTIONS. All required documents, including drawings and the design analyses, design documentation report, and engineering documentation report should be prepared in accordance with Chapter 2, titled PRESENTATION OF DATA. This chapter is applicable to the project phase described as 'pre-construction engineering and design' in a civil works project.

11.1.2 Purpose of Criteria.

The purpose of the following criteria is to facilitate the review of the drawings, to ensure that repetitive deficiencies in design will be eliminated and to ensure that all aspects of structural design are covered. They are not intended to be rigidly restrictive except in the use of local building codes.

11.2 Applicable Publications.

The latest issues of the publications listed below; referred to hereinafter by basic designation only, form a part of this Manual to the extent indicated by the references thereto.

11.2.1

Military Projects and Vertical Construction for Civil Works Projects

ACI 315	Manual of Standard Practice for Detailing Reinforced Concrete Structures
ACI 318	Building Code Requirements for Reinforced Concrete
AISC Manual	Manual of Steel Construction, Allowable Stress Design
AISC Manual	Manual of Steel Construction, Load and Resistance Factor Design
ASCE 7	Minimum Design Loads For Buildings and Other Structures
AASHTO	Standard Specification for Highway Bridges American Association of State Highway Traffic Officials
CABO	One and Two Family Dwelling Code

MBMA Manual	Metal Building Systems Manual of the Metal Building Manufacturer's Association
NEHRP-97	National Earthquake Hazard Reduction Program Provisions for New Buildings and Other Structures
SJI	Standard Specifications and Load Tables Of Specification The Steel Joist Institute and Tables
SDI	Steel Deck Institute, Diaphragm Design Manual
SSTD 10-97	Standard for Hurricane Resistant Residential Construction
SDI	Steel Deck Institute
TI 809-01	Load Assumptions for Buildings
TI 809-02	Structural Design Criteria for Buildings
TI 809-04	Seismic Design For Buildings
TI 809-07	Design of Cold-Formed Loadbearing Steel Systems and Masonry Veneer/Steel Stud Walls
TI 809-26	Welding, Design Procedures and Inspections
TI 809-27	Concrete Floor Slabs on Grade Subjected to Heavy Loads
TI 809-29	Structural Considerations for Metal Roofing
TI 809-30	Metal Buildings
TM 5-809-3	Masonry Structural Design For Buildings
TM 5-809-6	Structural Design Criteria for Structures Other than Buildings
TM 5-818-7	Foundations in Expansive Soils
TM 5-822-7	Standard Practice for Concrete Pavements
ER 1110-345-700	Design Analysis, Drawings, and Specifications

11.2.2 Civil Works Projects

ER 1110-2-1150	Engineering and Design for Civil Works Projects
ER 1110-2-1200	Plans and Specifications for Civil Works Projects
ER 1110-2-8155	Hydro Meteorological Data Management and Archiving

EM 1110-2-2000	Standard Practice for Concrete for Civil Works Structures
EM 1110-2-2007	Structural Design of Concrete Lined Channels
EM 1110-2-2104	Structural Design for Reinforced Concrete Hydraulic Structures
EM 1110-2-2200	Gravity Dam Design
EM 1110-2-2201	Arch Dam Design
EM 1110-2-2400	Structural Design of Spillways and Outlet Works
EM 1110-2-2502	Retaining and Flood Walls
EM 1110-2-2503	Design of Sheep Pile Cellular Structures, Cofferdams And Retaining Structures
EM 1110-2-2504	Design of Sheet pile Walls
EM 1110-2-2705	Structural Design of Closure Structures for Local Flood Protection Projects
EM 1110-2-3102	General Principles of Pumping Station Design & Layout
EM 1110-2-3104	Structural & Architectural Design of Pumping Stations
EM 1110-2-6050	Response Spectra and Seismic Analysis for Concrete Hydraulic Structures

In addition to, or in lieu of these stated references, certain projects may be specifically required to incorporate or to be designed in accordance with certain local, regional, or nationally accepted building codes. These will be stated on a project specific basis, as required by the using entity.

11.3 PROJECT DEFINITION (10-15%).

When required, this submittal will consist of a narrative describing load and general design criteria and any unusual design conditions, design analysis, and ½ size drawings. The narrative should include a brief description of the intended structural and foundation system or if the size of the project warrants, a description of the structural systems to be used for the comparative analysis. In the event that the design, architectural, or functional requirements or site conditions dictate the system selection, a statement to this effect shall be included and justified. When required for civil works projects, this information shall be included as part of the Design Documentation Report.

11.3 CONCEPT DESIGN (30-35%)

All requirements discussed in the following paragraphs shall be included in the Design Documentation Report for civil works projects, and shall be a stand alone document for military or other projects.

11.4.1 Structural System Selection Analysis.

An economical structural system will be selected to meet the requirements of the design. For projects with a construction value of $10,000,000 or greater, a comparative analysis of two or more competitive structural systems will be required unless indicated otherwise in the Statement of Work (SOW). A portion of each facility large enough to be representative of the entire structure should be designed in enough detail to provide for an estimate that will be the basis of the structural system selection. The portion of the structure selected for comparing alternate system costs should include framing for at least one typical bay of the structural system. Additional costs of nonstructural systems attributable to a structural alternative should be included in the comparative cost estimate for that alternative. Determination of these additional costs must be based upon a concept of the complete structural configuration, including architectural, mechanical, electrical, and other systems. The method of providing the required degree of fire-resistance should be determined for each alternative and the cost must be included. The submittal should include the following items:

(a) A complete description, with sketches, of each structural system considered.

(b) Design calculations supporting the member sizes used for the cost estimate.

(c) A comparative cost for each system, clearly showing all costs and quantities used.

(d) An analysis of the study results with justification for the system selected.

For projects with a construction value of less than $10,000,000, a brief rational justification of the proposed structural system will be presented.

11.4.2 Concept Design Analysis.

Provide calculations necessary to demonstrate the adequacy of the selected structural system and member sizes. The following specific items should be included:

11.4.2.1 Live Loads.

Live load values to be used in the design should be identified, including roof and floor loads, wind loads, lateral earth pressure loads, seismic loads, and hydraulic loads, as applicable. The narrative should state the basic wind speed and exposure category, and cite the reference that is the basis for calculating wind pressures.

11.4.2.2 Lateral Stability Analysis

The method of providing lateral stability for the proposed structural system to meet seismic and wind load requirements should be described. The analysis should include sufficient calculations to verify the adequacy of the proposed method of support. Sliding, flotation, and overturning stability should be addressed for hydraulic structures.

11.4.2.3 Fire Resistance.

Materials selected must be in consonance with the fire rating requirements of the structure.

11.4.2.4 Structural Calculations.

Calculations for typical structural members as applicable for the structural system proposed to be used are required.

11.4.2.5 Seismic Design coefficients.

Where seismic design is required, include the design coefficients to be used in computing the seismic forces. Describe the structural system to be used to resist these forces and any special seismic design features such as setbacks, seismic separation joints, etc.

11.4.3 Concept Drawings.

Sufficient framing plans are required for roof, floors, and foundations, as applicable, to indicate layout of principal members. Typical sections should be furnished through roof, floors, and foundations indicating materials and type of construction proposed.

11.5 INTERIM DESIGN (50-60%)

11.5.1 Interim Design Analysis.

The interim design analysis should include all items in the concept design analysis and any revisions necessitated by comments on the Concept Submittal. Calculations shall be included for all principal members, including the foundations. Revise or expand narrative to reflect latest design conditions.

11.5.2 Interim Drawings.

Drawings for this submittal will include roof and floor framing plans, as applicable. Principal members will be shown on the plans. A foundation plan will also be furnished showing main footings and grade beams where applicable. Where beam, column, and footing schedules are used, they will be filled in sufficiently to indicate typical member sizes to be used. Typical bar bending diagrams should be included if applicable. Typical sections will be furnished for roof, floor, and foundation conditions. Comments made on Concept Submittal should be incorporated into the drawings for this submittal.

11.5.3 Interim Specifications.

The interim submittal should include a list of all specification sections to be provided in the final design submittal. Certain projects may at the user request require the submittal of redlined specification sections at the interim submittal stage. The specific requirements for a project should be clarified during negotiations.

11.6 FINAL DESIGN (Unreviewed 100%).

11.6.1 Design Analysis.

Complete calculations for all structural members shall be included; any changes required by comments on the Interim and Concept Design Submittals must be incorporated.

11.6.2 Drawings.

Complete final plans and details of all structural elements are required. Prior to this submittal, structural drawings will have been coordinated with all other design disciplines. Drawings will contain a complete set of general notes indicating design live, wind, and seismic loading. All applicable material strengths will be indicated. All roof and floor openings, with details, will be shown on the structural drawings. The structural designer shall ensure that all mechanical and electrical equipment is properly supported and that all architectural features are adequately framed and connected, especially where seismic design is required.

11.6.2.1 Additional Drawing Requirements

(1) Use standard details and notes shown on enclosed plates where applicable.
(2) Use grade beam, slab, lintel, column and footing schedules where the size of the structure warrants.
(3) Show sufficient sections through all supported floors, steps, porches, mechanical equipment pads, cooling tower foundations, etc., and provide sufficient details to adequately show desired construction.
(4) Show steel column base details and detail all steel beam connections except standard AISC connections. Where connections are not detailed, show design shears and moments or indicate required connection capacities.
(5) All reinforced concrete sections should be detailed in accordance with the Manual of Standard Practice for Detailing Reinforced Concrete Structures by the American Concrete Institute, except as required by EM for hydraulic structures.
(6) In all seismic design, a statement of the seismic zone and coefficients used will be added to the tabulation of design loads in the General Notes.

11.6.3 Final Specifications.

The final submittal should include a set of all redlined specification sections in the final design submittal.

11.7 READY-TO-ADVERTISE (100)%

11.7.1 Design Analysis.

Final structural calculations will be furnished, incorporating all changes made during the process of design. Calculations will be checked and verified by an engineer other than the original designer.

11.7.2 Drawings.

Drawings will incorporate all comments from previous submittals. All drawings should be verified, finalized, and consistent with the specifications.

11.7.3 Ready-To-Advertise Specifications.

Specification sections will incorporate all comments from previous submittals. All redlines will be removed from the specification sections and the specifications shall be checked for brackets, section references, and publication references.

11.8 TECHNICAL REQUIREMENTS.

11.8.1 Design Loads.

Load assumptions should be in accordance with TI 809-01 and ASCE 7 with the following modifications.

11.8.1.1 Wind Loads.

The design requirements of ASCE 7 will be used, except for standard metal buildings and one and two family housing. Local building code requirements do not apply and will not be used. The wind load criteria to be used for standard metal buildings should be as set forth in the (MBMA) Metal Building Manufacturer's publication, Recommended Design Practice Manual. See TI 809-30 for an explanation of what is to be considered a standard metal building. Wind-load criteria to be used for family housing should be as set forth in the CABO One and Two Family Dwelling Code. Family housing projects located near coastal areas of the Gulf of Mexico and the Atlantic Ocean shall comply with the design requirements of the latest edition of the Standard Building Code.

11.8.1.2 Seismic Load Criteria.

(a) Family Housing. Seismic criteria used for family housing should be as set forth in US Army Technical Standards for Family Housing, Part III. This standard refers to HUD Bulletin 4910.1, which states that, ". . . structures should be designed to withstand the lateral forces provided for in the latest issue of the Uniform Building Code by the International Conference of Building Officials (UBC)."

(b) Bridges. Seismic criteria used for bridges should be as set forth in the Standard Specification for Highway Bridges, American Association of State Highway and Transportation Officials (AASHTO).

(c) All Other Structures. Seismic criteria used for structures other than family housing and bridges should be as set forth in TI 809-04 and NEHRP-97.

Particular attention should be given to details for the reinforcement of masonry construction. The horizontal and vertical wall reinforcement and reinforcement around openings should be clearly shown on the structural drawings and coordinated with the sections and details on the architectural drawings.

11.8.1.3 Minimum design pressures for interior walls and partitions shall be 5 psf.

11.8.2 Structural Steel.

Steel structures should be designed in accordance with American Institute of Steel Construction Specification (AISC). Shop connections for structural steel will be welded, and field connections will generally be made with high-strength bolts, ASTM A325 bearing-type connections. All connections other than standard AISC beam connections will be designed by the structural engineer and detailed on the final plans. When standard AISC beam connections are used, beam end reactions will be provided on the drawings. Design responsibility for all connections remains with the designer's Engineer of Record. Unless the structure involves very minor structural steel fabrication, the structural steel specification will be edited to include the requirement that the steel fabricator shall be certified by the AISC Quality Certification Program for the appropriate category.

11.8.3 Steel Joists.

Steel joist construction will be in accordance with the Steel Joist Institute Specifications. Joists will be anchored to steel supports by bolting or field welding. Steel insert plates will be provided in concrete work as required. Maximum joist spacing will be 2.5 feet for floors and, generally, 4.0 feet for roofs. Where top chords are extended, the required section modulus of extensions will be shown on the drawings. Where equipment is hung from joists, details of joist reinforcement at hangar locations should be provided on the drawings.

11.8.4 Steel Roof and Floor Deck.

Where steel roof and floor deck is used, required section modulus and moments of inertia should be shown on drawings. The type and quantity of decking connectors to be used to resist computed wind uplift and shear diaphragm forces should be clearly detailed on the final plans. Steel deck diaphragms shall be designed in accordance with the Steel Deck Institute “Diaphragm Design Manual”. All decking shall have a minimum galvanized coating conforming to ASTM A653, G60. Steel roof deck material should have a minimum thickness of 22 gage; steel form decking should have a minimum thickness of 26 gage. When the underside surface of large areas of steel decking is exposed to view and indicated to be finish painted, the underside surface of the steel decking will be specified to be factory cleaned and primed.

11.8.5 Concrete.

Concrete design should be in accordance with ACI 318 except as indicated below:

(a) All edge or spandrel beams should have continuous reinforcing top and bottom. As a minimum, 2 #5 bars, top and bottom should be used. Beams should also have continuous ties at a maximum spacing of 16 inches.

(b) Floor slabs on grade subject to live loads of 150 psf and under will be a minimum of 4 inches thick and reinforced with 6 X 6-W2.0 X W2.0 welded wire fabric placed approximately 1-1/2 inches from top of slab. Floor slabs-on-grade subject to heavy loads shall be designed in accordance with TI 809-27.

(d) The reinforcing of concrete walls, continuous footings, and tie and bond beams should be continuous and, therefore, typical details showing the arrangement of reinforcing at corners and intersections of these members should be shown on the drawings.

(e) All reinforced concrete should be detailed in accordance with the Manual of Standard Practice for Detailing Reinforced Concrete Structures, by the American Concrete Institute (ACI 315-Latest), unless noted otherwise.

11.8.6 Masonry Construction.

Masonry construction should be designed in accordance with TM 5-809-3. Location and details between bond beams and reinforcing may be shown on the architectural plans and sections, but will be checked by the designer's Structural Engineer for structural adequacy. Lintels for all openings in exterior and interior masonry walls, including windows, doors, and mechanical features such as ducts, should be shown on the drawings. Continuous bond beams should be provided at all floor and roof levels. A minimum of 2 #5 bars will be furnished at roofs.

11.8.7 Cold-Formed Steel Roof Trusses.

Cold-formed steel roof trusses shall be designed in accordance with TI 809-07. When the roof trusses are to be designed by the contractor the proper truss load diagrams shall be provided on the drawings. The diagrams shall show the design span length and all appropriate load components. Details showing required bearing conditions and connections shall be shown on the contract drawings. A special specification section shall be prepared for the cold-formed steel roof trusses. The use of field fabricated trusses shall be limited to only minor trusses. The truss fabricator shall be required to have a certain minimum amount of experience in the production of steel roof trusses and complete shop drawings showing erection plan, truss configurations, and truss joint connections shall be required to be submitted for approval. The use of trusses manufactured from custom steel shapes specifically designed by the truss manufacturer shall be specified to the greatest extent possible.

11.8.8 General.

(a) The designer's Structural Engineer is responsible for insuring that all mechanical and electrical equipment and other auxiliary building features such as sprinkler piping, etc. are properly supported and that all architectural features are adequately framed and connected.

(b) When future expansion of buildings or facilities is planned, it is especially important that the provisions made for the expansion are carefully developed and shown on the drawings.

(c) Structural details will be shown on the structural plans and not intermixed with architectural plans and details.

11.8.9 Required Standard Details

Certain standard structural details are required, as applicable, on all projects. The following CADD files are available on the Internet. See Chapter 2 titled Presentation of Data; paragraph 2.5.2.1 Internet for access procedures. Details furnished on these files not applicable to a specific project should not be included in the project drawings.

ZMASON1.DGN AND .DWG	TYPICAL MASONRY DETAILS
ZMASON2.DGN AND .DWG	TYPICAL MASONRY DETAILS

CHAPTER 12

PLUMBING

INDEX

CHAPTER 12

PLUMBING

12.1 GENERAL.

12.1.1 Scope.

This chapter provides guidance for preparation and development of plumbing (including compressed air, fuel gas, and medical gas systems). Specific design submittal requirements in this chapter supplement the requirements in Chapter 1, titled GENERAL INSTRUCTIONS. All required documents, including drawings and design analysis, shall be in accordance with Chapter 2, titled PRESENTATION OF DATA.

12.2 APPLICABLE PUBLICATIONS.

The publications listed below, but referred to thereafter by basic designation only, form a part of this Manual. These publications are supplemented by the Corps of Engineers Guide Specifications (CEGS) to form design criteria.

Lead Design Manual:

AEI Architectural and Engineering Instructions, Design Criteria

Supplemental Air Force Design Manuals:

MIL-HDBK-1190	Facility Design Guide
MIL-HDBK-1191	Facility Design Guide – Medical

Department of the Army Technical Manuals (TM):

TM 5-810-5	Plumbing
TM 5-810-4	Compressed Air

Design for the Physically Handicapped:

Uniform Federal Accessibility Standards

CEGS Guide Specifications:

SECTION 13290	Composting toilet
SECTION 13600	Solar water heating equipment
SECTION 15400	Plumbing, general purpose
SECTION 15405	Plumbing, hospital
SECTION 15488	Gas piping systems

Mobile District Guide Specifications:

SECTION 15480 Compressed air distribution systems, exterior

12.3 PROJECT DEFINITION (10-15%).

12.3.1 General Considerations.

(a) At the Project Definition phase the designer must define the customer's requirements and confirm that they can be met within the project's constraints. To that end, a comprehensive interface with the customer is required generally through a Charrette or other previously approved data gathering process. The primary purpose of the design process at this stage is to gather any information from the customer that would be necessary in the design of the facility. Also, the design preferences of the customer should be obtained for compliance if possible.

(b) The general plumbing system type and purpose along with an order-of-magnitude estimate of major equipment sizes will be provided at the Project Definition phase for use in preparing the cost estimate and sizing the required mechanical spaces.

12.3.2 Project Definition Narrative.

The Project Definition narrative shall include, but not be limited to, the following items as applicable:

(a) List all references used in the Project Definition design including Government design documents, industry standards, safety manuals, and criteria given to designer at the charrette or predesign meeting.

(b) Explain proposed type of the plumbing system.

(c) List the major equipment and give the sizes in general order-of-magnitude.

(d) Describe any demolition required.

(e) List any environmental concerns and actions to be taken to address them.

12.4 CONCEPT DESIGN (30-35%).

12.4.1 General Considerations.

(a) At the Concept design stage of project development, it is recognized that all calculations are preliminary for analysis purposes and only indicate approximate capacities of equipment. Any dimensions and sizes required are order-of-magnitude figures, conversationally stated, to insure adequate space for installation and maintenance of equipment and utility elements such as piping, etc., in congested areas.

(b) Equipment shown in plans and sections need not be shown in great detail but is shown merely as simple geometric forms with approximately correct dimensions.

(c) Piping layouts shown are simple main pipe runs showing general location, routing and, when applicable, approximate order-of-magnitude sizes.

(d) Schematic diagrams are simplified. The purpose of the schematic is only to show system design intent and the basic principle of system operation.

(e) Drawings and sketches. Scale of concept drawings will generally be smaller than the working drawings. Plans and sections need be only large enough to properly show pertinent information. Sketches, neatly drawn, will be acceptable when sufficient to show pertinent information or to convey basic system concepts. Quantity of concept drawings is to be kept to the minimum number required to convey basic systems information. Some mechanical information required in the Concept submission may logically be included on other discipline drawings or in sketch form in the design analyses and need not be completed on formal drawings.

12.4.2 Concept Design Analysis.

The Concept Design Analysis shall include but not be limited to the following items as applicable:

(a) List all references used in the Concept design including Government design documents, industry standards, criteria given to designer at pre-design meeting, etc.

(b) Provide justification and a brief description of the types of plumbing fixtures, piping materials, and equipment proposed for use.

(c) Prepare basic preliminary calculations for systems such as sizing of domestic hot water heater and piping, compressed air piping, compressors and receivers, vacuum piping, vacuum pumps and receivers, natural gas piping, and container gas piping and tanks.

(d) Describe any demolition required.

12.4.2.1 Specifications.

Provide a basic outline in accordance with Chapter 3, SPECIFICATIONS.

12.4.3 Concept Drawings.

The Concept design drawings should include, but not be limited to, the following items as applicable:

(a) Indicate locations and general arrangement of plumbing fixtures and major equipment.

(b) Indicate location and extent of any demolition that will be required concerning the plumbing system.

12.5 INTERIM DESIGN (50-60%).

In addition to the following items, the designer shall incorporate or answer all comments received from the COE and customer concerning the Concept submittal.

12.5.1 Interim Design Analysis.

The Interim Design Analysis shall include all items in the Concept design analysis and any necessary revisions. In addition, the following specific items shall be included when applicable: Provide detailed calculations for the sizing of the following systems: domestic hot water, domestic cold water, waste and vent, natural and LP gases, vacuum, compressed air, distilled or deionized water, medical gases, and other specialty systems. Identify and address any security requirements.

12.5.1.1 Specifications.

The outline specifications previously submitted for concept phase shall be revised, updated, further developed and resubmitted in accordance with Chapter 3, titled SPECIFICATIONS.

12.5.2 Interim Drawings.

The Interim drawings should show all information given on the concept drawings but in greater detail. In addition, the Interim drawings should include, but not be limited to, the following items as applicable:

(a) Include plan and isometric riser diagrams of all areas including hot water, cold water, waste, and vent piping. Piping layouts and risers should also include natural gas (and meter as required), LP gas, vacuum systems, compressed air systems, distilled or deionized water, medical gases, and other specialty systems as applicable.

(b) Include equipment and fixture schedules with descriptions, capacities, locations, connection sizes, and other information as required.

12.6 FINAL DESIGN (Unreviewed 100%).

In addition to the following items, the designer shall incorporate or answer all comments received from the COE and the customer concerning Interim submittal.

12.6.1 Final Design Analysis.

The Final Design Analysis shall include all of the information required in the Interim submittal in its final form and Incorporate or answer all comments received from the COE or the customer.

12.6.1.1 Specifications.

Marked-up draft specifications shall be submitted in accordance with Chapter 3, titled SPECIFICATIONS. Specifications used shall be those acquired subsequent to the Interim submittal.

12.6.2 Final Drawings.

The Final drawings for plumbing systems should be in a Ready-to-Advertise state which should include, but not be limited to, the following items as applicable.

(a) Plans, sections, details and riser diagrams in final condition.

(b) Complete all legends and schedules.

(c) Complete all narratives, notes, and title blocks as necessary.

12.7 READY-TO-ADVERTISE (100%).

The comments generated concerning the Final submittal shall be incorporated in the documents before they are submitted as "Ready-to- Advertise."

12.7.1 Specifications.

The designer shall prepare the final detailed Technical Provisions of the specifications in accordance with Chapter 3, titled SPECIFICATIONS.

12.8 TECHNICAL REQUIREMENTS.

12.8.1 General Considerations.

(a) Coordinate space requirements, foundations, supports, pipe routing, electrical service, and the like for mechanical items with architectural, structural, and electrical design elements. Coordinate exterior mechanical distribution systems with design elements handling other exterior utility designs and site work.

(b) Standard or "packaged" equipment shall be used to the greatest extent possible to simplify specifying, purchasing, installation, and maintenance of equipment.

(c) AEI, Design Criteria, is the prime design manual. For Air Force projects, MIL-HDBK-1190 supplements it. For Army projects various manuals in the TM 5-810 series supplement it. In case of conflict, the AEI, Design Criteria governs.

(d) Plumbing shall not traverse over or under electrical panels or switchboards.

12.8.2 Plumbing Considerations.

(a) Piping System. Piping materials and sizes shall comply with the recommendations in the National Standard Plumbing Code and TM 5-810-5. Flow velocities in water pipe shall not exceed 10 feet per second. All piping shall be sloped to permit complete drainage and must be properly supported with allowances for expansion and contraction. Expansion loops or expansion joints and anchor points shall be shown on plumbing drawings. Piping subject to freezing shall be suitably protected.

(b) Wall Hydrants and Lawn Faucets. The maximum spacing between wall hydrants or between lawn faucets around the perimeter of a building is 200 feet. Add 5 gpm for each hydrant or faucet to building load for sizing water main.

(c) Floor Drains. Floor drains shall be provided in all boiler and mechanical equipment rooms and adjacent to each emergency deluge shower. In addition, all other areas listed as requiring floor drains in TM 5-810-5 shall be provided for.

(d) Grease interceptors shall be installed outside of buildings in accordance with TM 5-810-5.

(e) Backflow Prevention: The water distribution system shall be protected against the flow of water or other liquids into the distributing pipes from any unintended source or sources. Refer to the National Standard Plumbing Code for requirements on all systems.

(f) Domestic Hot Water. In the design of any buildings in which water closets and showers are installed, the designer shall exercise the necessary precautions to prevent personnel from being scalded while taking showers due to simultaneous operation of water closets equipped with flush valves.

(1) Domestic Hot Water Temperature. Domestic hot water supply maximum temperatures at the point of use will be as follows for the indicated facilities or areas unless higher temperatures are required for sanitizing or special processes:

(a) In all latrines, heads, and toilet facilities without showers or tubs, the actual measured temperature of hot water delivered to the user shall not exceed 130 F.

(b) In all latrines, heads, and toilet facilities with showers or tubs, the actual measured temperature of hot water delivered to the user shall not exceed 120 F.

(c) In buildings such as BOQ's and BEQ's where there may be toilet facilities both with and without showers or tubs, where there is both heavy and frequent use of the bathing facilities, where there is a common hot water supply system, the delivered temperature of 120 F may be used for all facilities.

(d) In buildings such as administrative, where showers are provided only in a few special cases, such as for the commanding officer and duty officer, the delivered water temperature shall exceed 120 F. The same condition shall prevail in laboratory and special buildings where showers are provided for emergency or exceptional use, or where the number of users or frequency of use is low.

(2) It is recognized that in some older buildings or in some unusual cases it may be necessary to do more than reset existing temperature controllers. In some cases, added storage tanks, temperature blending equipment, or separate lines might be required. Where the aggregate of this work on any one installation meets the minimum requirements for the Energy Conservation Investment Program, consideration should be given to including the work under this program, provided the ECIP amortization guidelines can be met.

(3) A water blending system using a 3-way mixing valve may be used where equipment room space is limited and/or the water heater is designed to supply hot water at temperatures greater than required.

(4) Domestic hot water requirements for medical facilities will be as specified in Mil Handbook 1191.

(5) Buildings normally occupied during a 40-hour work week, one or two shifts per day (5-day or 7-day week), will have time clocks on domestic hot water circulating pumps to limit operation to periods of occupancy.

(g) Compressed Air. Unless requirements are stated in specific instructions, compressed air system and compressor sizes will be determined by the designer from analysis of equipment layout and/or coordination with the customer's requirements. Design shall be in accordance with TM 5-810-4.

(h) LPG. LPG shall not be used as fuel for any heating unit larger than 250,000 Btu/hr or for a plant with output greater than 750,000 Btu/hr, including family housing application.

(i) Gas Distribution and Gas Fittings. Gas distribution system specification will extend from point of connection with existing main to a point 5 feet from the building. Gas fitting specification begins with the connection at the 5-foot mark and covers all interior gas piping. Maximum line pressure in gas distribution systems shall be 50 psig in lieu of 25 psig specified in TM 5-848-1.

(j) Fixture Selection. All specifications and references to outfit numbers and figure numbers shall be as defined in Federal Specification WW-P-541D. Unless they are an integral part of the fixture, bathroom and toilet accessories, such as prefabricated shower stalls, towel bars, mirrors, etc., shall be included in other specifications.

(k) Design for the Physically Handicapped. Appropriate modifications to plumbing fixtures as required by Uniform Federal Accessibility Standards shall be included in all projects designated to be suitable for access by the physically handicapped.

(l) Equipment Schedules.

(a) Plumbing Fixtures. Each set of drawings for a project or building shall include one or more fixture schedules that will designate the symbols, P numbers, outfit numbers, description, and sizes of connections.

(b) Other Equipment. The equipment information indicated in "Equipment Notes" in TM 5-810-5 will be supplemented, expanded as required and put on drawings as Equipment Schedules.

12.8.3 Seismic Protection.

All piping, equipment, and utilities for jobs located in seismic zones must be protected in accordance with TM 5-809-10.

CHAPTER 13

HEATING, VENTILATING, AND AIR CONDITIONING

INDEX

CHAPTER 13

HEATING, VENTILATING, AND AIR CONDITIONING

13.1 GENERAL.

13.1.1 Scope.

This part of the chapter provides guidance for preparation and development of the following design aspects: heating, ventilating, air conditioning (including chilled water and dual temperature water distribution systems). Specific design submittal requirements in this chapter supplement the requirements in Chapter 1, titled GENERAL INSTRUCTIONS. All required documents, including drawings and design analysis, shall be in accordance with Chapter 2, titled PRESENTATION OF DATA.

13.2 APPLICABLE PUBLICATIONS.

The issue of the publications listed below, but referred to thereafter by basic designation only, form a part of this Manual. These are supplemented by the Corps of Engineers Guide Specifications (CEGS) to form design criteria.

Army Design Manual:

AEI	Architectural and Engineering Instructions, Design Criteria

Department of the Army Technical Manuals (TM):

TM 5-805-4	Noise and Vibration Control for Mechanical Equipment
TM 5-810-1	Mechanical Design Heating, Ventilating and Air Conditioning
TM 5-810-17	Heating and Cooling Distribution Systems
TM 5-810-3	Heating, Ventilating and Air Conditioning (HVAC) Control Systems

Military Handbooks:

MIL-HDBK-1190	Facility Planning and Design Guide

American National Standard Institute (ANSI):

B31.1	Power Piping

American Society of Mechanical Engineers (ASME):

Section IV	Heating Boilers
Section VIII	Pressure Vessels, Division 1

Technical Instruction (TI):

TI-809-04	Seismic Design for Bldgs.

Air Conditioning and Refrigeration Institute (ARI):

Std 210	Unitary Air Conditioners
Std 240	Unitary Air Source Heat Pumps
Std 310	Packaged Terminal Air Conditioners
Std 320	Water Source Heat Pumps
Std 380	Packaged Terminal Heat Pumps
Std 410	Air Cooling and Air Heating Coils
Std 440	Room Fan Coil Air Conditioners

American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) Inc. Standards:

Latest Edition	HVAC Applications
Latest Edition	HVAC Systems and Equipment
Latest Edition	Fundamentals
Latest Edition	Refrigeration

Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) Inc.:

Latest Edition	HVAC Metal Duct Standards
Latest Edition	HVAC Systems - Testing, Adjusting, and Balancing

National Fire Protection Association (NFPA) Standards:

Latest Edition	National Fire Codes

CEGS Guide Specifications:

SECTION 13080	Seismic protection for mechanical, electrical equipment
SECTION 15080	Thermal insulation for mechanical systems
SECTION 15500	Desiccant-cooling systems
SECTION 15555	Central high temperature water (htw) generating plant and auxiliaries
SECTION 15556	Forced hot water heating systems using water and steam hot exchangers

SECTION 15566	Warm air-heating systems
SECTION 15569	Water and steam heating; oil, gas or both; up to 20 btuh
SECTION 15650	Central refrigeration system (for air-conditioning system)
SECTION 15652	Cold storage refrigeration systems
SECTION 15653	Air-conditioning system (unitary type)
SECTION 15690	Evaporative cooling systems
SECTION 15775	Field-Erected heat pump system
SECTION 15845	Energy recovery systems
SECTION 15848	Thermal energy storage units: ice-on-coil
SECTION 15846	Heat recovery boilers
SECTION 15895	Air-supply and distribution system (for air-conditioning system)
SECTION 15940	Overhead vehicle tailpipe [and welding fume] exhaust system(s)
SECTION 15950	Heating, ventilating and air conditioning hvac control system
SECTION 15951	Direct digital controls for HVAC
SECTION 15990	Testing, adjusting and balancing of hvac systems
SECTION 15995	Commissioning hvac systems

13.3 ENERGY BUDGET AND ECONOMIC STUDIES.

Energy Budget and Economic Studies will be done in accordance with Chapter 20, titled ENERGY AND ECONOMIC STUDIES. Requirements for Energy Monitoring and Control System (EMCS) are provided in Chapter 21, titled ENERGY MONITORING AND CONTROL SYSTEM (EMCS).

13.4 PROJECT DEFINITION (10-15%).

13.4.1 General Considerations.

(a) At the Project Definition phase the designer must define the customer's requirements and confirm that they can be met within the project's constraints. To that end, a comprehensive interface with the customer is required generally through a charrette or other previously approved data gathering process. The primary purpose of the design process at this stage is to gather any information from the customer that would be necessary in the design of the facility. Also, the design preferences of the customer should be obtained for compliance if possible.

(b) The general HVAC system type and purpose along with an order-of-magnitude estimate of major equipment sizes will be provided at the Project Definition phase for use in preparing the cost estimate and sizing the required mechanical spaces.

13.4.2 Project Definition Narrative.

The Project Definition narrative shall include, but not be limited to, the following items as applicable:

(a) List all references used in the Project Definition design including Government design documents, industry standards, safety manuals, and criteria given to designer at the Charrette or predesign meeting.

(b) Explain purpose and proposed type of the environmental system (i.e., personnel comfort, process or computer cooling, freeze protection or otherwise).

(c) Include the probable outcome of the Life Cycle Cost Analysis based on past experience or common sense.

(d) State the design conditions including indoor and outdoor temperatures, relative humidities for summer and winter conditions, filtration and ventilation requirements, personnel loads, special equipment loads, etc.

(e) State the proposed building characteristics including 'U' Factors of walls, floors, roofs, windows, etc., orientation of the building, latitude and longitude of location, and any special conditions that would have an impact on HVAC design.

(f) List the major equipment and give the sizes in general order-of-magnitude.

(g) Briefly describe the proposed control system type. Also, discuss any requirements for connection to the installation EMCS systems.

(h) Discuss requirements for natural gas, fuel oil, and water flow meters.

(i) Describe any demolition required.

(j) List environmental concerns and actions to be taken to address them.

13.5 CONCEPT DESIGN (30-35%).

13.5.1 General Considerations.

(a) At the Concept design stage of project development, it is recognized that all calculations are preliminary for analysis purposes and only indicate approximate capacities of equipment. Any dimensions and sizes required are order-of-magnitude figures, conversationally stated, to assure adequate space for installation and maintenance of equipment and utility elements such as piping, ductwork, etc., in congested areas.

(b) Equipment shown in plans and sections is not shown in great detail but is shown merely as simple geometric forms with approximately correct dimensions.

(c) Piping layouts shown are simple main pipe runs showing general location, routing and, when applicable, approximate order-of-magnitude sizes. Control valves, check valves, etc., are shown only as required to indicate function of the system. Only routing of main headers feeding batteries of water coils are shown, not individual lines to coils unless required for clarity of the system.

(d) Schematic diagrams are simplified. System flow diagrams, layouts, and one of each type of take-off, branch, or feed must be shown but not all individual branches. The purpose of the schematic is only to show system design intent and the basic principle of system operation.

(e) Drawings and sketches. Scale of concept drawings may be smaller than the working drawings. Plans and sections need be only large enough to properly show pertinent information. Sketches, neatly drawn, will be acceptable when sufficient to show pertinent information or convey basic system concepts. Quantity of concept drawings are to be kept to the minimum number required to convey basic systems information. Some mechanical information required in the Concept submission may logically be included on other discipline drawings or in sketch form in the design analyses and need not be completed on formal drawings.

(f) Throughout the design submittals and on the Ready-to-Advertise drawings, abbreviations used on drawings shall conform to ASHRAE Fundamentals and shall be indicated in the mechanical drawing legend.

13.5.2 Concept Design Analysis.

The Concept Design Analysis shall include, but not be limited to, the following items as applicable:

(a) List all references used in the Concept design including Government design documents, industry standards, safety manuals, criteria given to Designer at predesign meeting, etc.

(b) Explain purpose of the environmental system (i.e., personnel comfort, process or computer cooling, freeze protection or otherwise).

(c) Include Energy Budget and Economic Studies, the effects thereof on the design, systems, equipment, etc., and describe the systems studied as well as the system selections resulting from these studies See Chapter 20 titled ENERGY AND ECONOMIC STUDIES.

(d) State the design conditions including indoor and outdoor temperatures, relative humidities for summer and winter conditions, filtration and ventilation requirements, personnel loads, special equipment loads, etc.

(e) State building characteristics including 'U' Factors of walls, floors, roofs, windows, etc., orientation of the building, latitude and longitude of location, and any special conditions that would have an impact on HVAC design.

(f) Prepare basic calculations such as typical room loads, block loads for heating and cooling systems, approximate CFM, GPM (or applicable units) quantities, and a balance flow diagram showing quantities of air handled and circulated throughout each building as a whole (including quantities for outside and exhaust air).

(g) Briefly describe the proposed sequence of control for temperature, humidity, ventilation, etc. Also, discuss any requirements for connection to the installation EMCS Systems.

(h) Discuss requirements for natural gas, fuel oil and water flowmeters.

(i) Describe any demolition required.

(j) Provide a basic outline specification in accordance with Chapter 3, titled SPECIFICATIONS.

13.5.3 Concept Drawings.

The Concept design drawings should include, but not be limited to, single-line layouts of heating and air conditioning systems showing equipment and contemplated zoning for each building. Drawings shall indentify rooms and be sufficiently complete to show the location, arrangement, approximate capacities of all major items of equipment, and space allocated for servicing and maintenance. Include the following items:

(a) Single-line layouts of HVAC systems with preliminary representative duct sizes of main runs and air quantities. This includes exhaust systems and makeup air systems. Representative sections of ducts in congested areas should be shown double line. In accordance with letter from the Assistant Secretary of Defense, dated 14 June 1984, new DOD policy prohibits ductwork in the following applications: Sub-slab or intra-slab; plenum-type, sub-floor; inclosed crawl space exposed to the ground; or where any part of the ducting is in contact or exposed to the ground.

(b) Sections through major mechanical spaces and all obviously congested spaces to indicate space requirements.

(c) Component parts of air handling equipment should be indicated (e.g, fan, coils, filters, etc.).

(d) Show required maintenance space for all major equipment, preferably with dashed lines.

(e) Show major piping single line with approximate size.

(f) Indicate preliminary approximate capacities of all major equipment, including horsepower of motors, KW of major electric heating elements, cfm of major air handlers, cooling and heating capacities, etc.

(g) Indicate location and extent of any demolition that will be required concerning the HVAC system.

13.6 INTERIM DESIGN (50-60%).

In addition to the following items, the designer shall incorporate or answer all comments received from the COE and the customes concerning the Concept submittal.

13.6.1 Interim Design Analysis.

The Interim Design Analysis shall include all items in the Concept design analysis and any necessary revisions. In addition, the following specific items shall be included when applicable:

(a) Provide detailed calculations for the following: heating loads, cooling loads, piping, ductwork, equipment sizing,etc. Computer calculations shall include print out of input data as well as output.

(b) Equipment selection: Equipment selection shall be based on not less than **three** manufacturers whose equipment meets project requirements for each item. The design analysis shall include catalog cuts of all major equipment (e.g., air handlers, coils, chillers, condensing units, boilers, pumps, fans, unit heaters, heat exchangers, etc.) used as the basis of the design indicating manufacturer, model number, dimensions, capacities, and electrical requirements. The project design is not complete until the designer is assured that there is sufficient physical space in areas where equipment is to be located to install and to maintain the selected equipment.

(c) Include any other information or calculations to verify that the design complies with applicable criteria codes or standards and is satisfactory for intended purposes.

(d) Major unforeseen costs and any changes from Concept submittal shall be referenced and the impact on energy and economic studies shall be indicated. Justification for departures, if any, from the original energy and economic study recommendations shall be provided.

(e) Explanatory notes shall be included in the design analysis covering all rationale for design which would not be obvious to an engineer reviewing the analysis. Methods of air conditioning and controls for air conditioning systems shall generally be confined to those in common use in the industry.

(f) Specifications: The outline specifications previously submitted with the Concept design shall be revised, updated, further developed and re-submitted in accordance with Chapter 4, titled SPECIFICATIONS.

13.6.2 Interim Drawings.

The Interim drawings should show all information given on the concept drawings but in greater detail. In addition, the Interim drawings should include, but not be limited to, the following items as applicable:

(a) Show all duct work and piping, with sizes and flow rates, where necessary for balancing purposes. Indicate the duct work pressures in accordance with SMACNA standards. Include all accessories and appurtenances.

(b) Show elementary ladder diagrams and temperature control schematics indicating remote sensors, panel mounted controllers, and thermostats.

Note: Except at fan coil units, VAV or dual duct air terminal unitary systems, panel mounted controllers with remote temperature and/or humidity sensors (without occupant adjustable set points) shall be indicated, and control panels shall be located away from vibrating machinery.

(c) Show layout and details of the final version of all HVAC systems. The location, arrangement, capacity, and space requirements of all equipment shall be indicated. Selected zones of air distribution shall be sufficiently completed to indicate the solution of the design for the remainder of the system and the precautions taken to coordinate the design with the architectural, structural, and electrical phases of construction. Equipment room layouts shall be sufficiently complete to show piping and duct layouts and access for maintenance. Since equipment rooms represent the most congested areas for both equipment and piping, the following guidelines should be followed when drawings are being prepared.

(1) Pipe fittings and accessory details shall be shown.

(2) All duct and fittings in congested areas and mechanical rooms shall be drawn to scale using double-line layouts. In a VAV system, ducts between the AHU and VAV boxes shall be double-lined and ducts downstream of the VAV boxes may be single lined.

(3) All equipment shall be outlined to scale, and maintenance or removal space shall be indicated by dashed lines.

(4) Removal and replacement space must be considered for the largest and heaviest equipment when a drawing is made.

(5) In other HVAC plans, sections, and details, these same guidelines shall apply.

(d) Show new exterior chilled water, dual temperature water, or steam distribution systems from central energy plants in plan and profile. Show all other exterior piping in plan.

(e) The final form of all equipment schedules shall be shown with preliminary equipment data filled in (see the equipment schedules in (Exhibit 13-1).

l3.6.3 <u>Energy Monitoring and Control System</u>.

Necessary provisions of Chapter 21, titled ENERGY MONITORING AND CONTROL SYSTEM (EMCS), will be incorporated.

13.7 <u>FINAL DESIGN (Unreviewed 100%)</u>.

In addition to the following items, the designer shall incorporate or answer all comments received from COE and customer concerning Interim submittal.

13.7.1 <u>Specifications</u>.

The designer shall provide complete edited draft specifications. The specifications shall be edited and tailored by the designer to meet the requirements of the project under design. The Contractor Submittal Register must be edited and included. The CEGS are **GUIDE** specifications only. The Designer is to delete what is not needed and add what is needed. Specifications shall be in accordance with Chapter 3, titled SPECIFICATIONS.

13.7.2 Final Design Analysis.

The Final Design Analysis shall include all of the information required in the Interim submittal in its final form and the information listed below when applicable:

(a) Include flow diagrams with all quantities for both air and water sides of complex HVAC systems for balancing purposes.

(b) Major unforeseen costs and any changes from Interim or Concept submittals shall be referenced and impact on energy and economic studies shall be indicated. Justification for departures, if any, from energy and economic study recommendations shall be provided.

(c) The designer shall review the prepared plans and specifications and determine that they are in accordance with this Manual and all other criteria and instructions furnished by the COE. It will be the responsibility of the designer to coordinate the HVAC systems with the other trades involved in the building design and to eliminate interference between HVAC equipment and other components of the building.

13.7.3 Final Drawings.

The Final drawings should be in a Ready-to-Advertise state which should include, but not be limited to, the following items as applicable:

(a) Include all plans, sections, and details in final condition.

(b) Include all completed legends and schedules.

(c) Show all necessary piping schematics in final form.

(d) Complete narratives, notes, and title blocks as necessary.

(e) Show all temperature control systems as follows:

(1) Location of sensors, thermostats, and control panels.

(2) Schematics. diagrams, layouts, legends, narratives, sequences, etc. as required by TM-5-815-3.

(3) NOTE: If required by the SOW, a Direct Digital Control system may be included as an option to the TM 5-815-3 control system. Compatibility with any existing control or monitoring systems must be insured.

13.7.4 Energy Monitoring and Control System.

Necessary provisions of Chapter 21, titled ENERGY MONITORING AND CONTROL SYSTEM (EMCS), will be incorporated.

13.8 READY-TO-ADVERTISE (100%).

The comments generated during the Final submittal shall be incorporated in the documents before they are submitted as "Ready-to- Advertise."

13.8.1 Specifications.

The Designer shall prepare the final detailed Technical Provisions of the specifications in accordance with Chapter 3, titled SPECIFICATIONS.

13.9 TECHNICAL REQUIREMENTS.

13.9.1 General Considerations.

(a) Coordinate space requirements, foundations, supports, duct and pipe routing, electrical service, etc., for mechanical items with architectural, structural, and electrical design elements. Coordinate exterior mechanical distribution systems with design elements handling other exterior utility designs and site work.

(b) Standard or "packaged" equipment shall be used to the greatest extent possible to simplify specifying, purchasing, installation, and maintenance of equipment.

(c) For Army projects, the AEI - Architectural and Engineering Instructions, Design Criteria, is the prime design manual. For Air Force projects Military Handbook MIL-HDBK-1190 - Facility Planning and Design Guide is the prime design manual.

13.9.2 HVAC Design Considerations.

(a) Design Temperatures.

(1) Indoor design temperatures shall be in accordance with AEI.

(2) Outdoor design conditions shall be in accordance with Exhibit 13-1.

(3) Manual cooling and heating load calculations shall be submitted on forms in accordance with ASHRAE Fundamentals. Computer printouts (program input data as well as output results) shall be submitted for calculations performed by automated procedures.

(b) Noise Control. All noise control design work shall be in accordance with TM 5-805-4. The sound levels for various applications for both propeller and centrifugal type fans shall be as set forth in the ASHRAE Guide and Data Books.

(c) Selection of HVAC Systems. In the design of HVAC systems, the environmental criteria of the facility will be carefully analyzed. Constant volume, terminal reheat, all types of variable air volume systems, and combinations of systems and central equipment shall be considered. Also, humid area criteria in accordance with AEI Design Criteria shall be followed in system type considerations and selection. A computerized systems simulation energy analysis will be required for each facility at the Concept design stage unless specific exception is provided in the SOW. See Chapter 20 titled ENERGY AND ECONOMIC STUDIES for requirements.

(d) Energy Saving Controls and Heat Recovery Devices. HVAC systems will be provided with automatic controls which will allow systems to be operated to conserve energy. Energy saving controls and heat recovery devices specified in the AEI, Design Criteria will be provided as appropriate based on the life cycle cost/energy analysis see Chapter 20, titled ENERGY AND ECONOMIC STUDIES. The following energy saving controls will be considered, if applicable to the system:

(1) Dry-Bulb controlled economizer cycle. Do not use in Humid Areas.

(2) Controls to close outside air supply when the facility is unoccupied.

(3) Night setback controls where appropriate.

(4) Master outdoor temperature sensing unit which modulates the hot water temperature in accordance with outdoor ambient temperature. This sensing unit shall automatically shut off the heating system and the circulating pumps when the outdoor temperature reaches 65 degrees F.

(5) Controls to shut off exhaust fans, where appropriate.

(6) Reset controls for hot and cold decks on air conditioning systems having hot and cold decks.

(e) Water Chillers.

(1) Chillers greater than 200 tons shall be centrifugal, helical rotary screw or absorption type. Centrifugal, helical rotary screw, or absorption machines of less than 200 tons capacity may be used at the discretion of the designer and if recommended by the economic calculations, See Chapter 20 titled ENERGY AND ECONOMIC STUDIES. Individual reciprocating machines used for air conditioning a single building shall not exceed 400 tons. When packaged water chillers, packaged air conditioning units, or packaged air-cooled air conditioning units are equipped with reciprocating compressors, the total capacity of any one packaged unit shall not exceed 200 tons. A single packaged unit of any type shall not contain more than eight compressors.

(2) For loads greater than 400 tons, a life-cycle cost study shall be made to determine whether two or three machines may be more economical than a single machine. In no case, where only personnel comfort is involved, shall consideration be given to a standby machine. Similarly, standby chilled water and condensing water pumps are not authorized. Exception to this policy may be granted in accordance with AEI, Design Criteria for those severe weather zones in which a critical mission function would be seriously effected by loss of personnel comfort cooling.

(3) Air conditioning systems generally operate at part load conditions for a great amount of time. This is particularly true of comfort conditioning systems which can operate at less than 50 percent of their design load over 50 percent of the time. Since high part load efficiencies are desirable to conserve energy, the selection of equipment and step

starting and sequencing controls shall be made with emphasis given to the reduced life cycle cost resulting from high part load efficiencies.

(4) Care must be taken in the design, specification, and procurement of built-up systems to insure compatibility of condenser, evaporator, and piping with the compressors.

(5) Water Cooled. When specifying a water cooled chiller system, a complete description of the cooling water treatment, automatic blowdown control, and cooling tower construction will be included.

(6) Humid Areas. The following criteria shall also be applied to humid areas as defined in AEI, Design Criteria and as indicated in Exhibit 13-1. The cooling capacity of chilled water systems of 100 tons and over shall be divided between two chillers to insure reliability and constant chilled water supply without temperature fluctuations, to prevent short cycling, and to minimize hot gas bypass. The combined capacity of the two chillers shall not exceed the total requirement, including diversity. Selection of chiller capacity should be based on the analysis of part load operating hours for extended periods at low load conditions.

(f) Air Handling Systems.

(1) Central station type package air handling units complete with filters, coils, and fan sections will be utilized where commercially available. Size and number of package units will be dependent upon availability and design considerations.

(2) Central station built-up systems comprised of filters, coils, and fan will be installed where system requirements cannot be satisfied with the factory-assembled package equipment. Maximum capacity for the built-up systems will be limited to 60,000 cfm. Total system demands in excess of 60,000 cfm will utilize multiple systems.

(3) Package air handling units will normally be located at floor level with adequate clearance for maintenance, test procedures, and equipment removal. Locations above ceilings, above mechanical equipment, and suspended 6 feet or more above the floor, are undesirable and should be avoided where possible.

(4) Humid Areas. Reference the AEI, Design Criteria for additional requirements for humid areas. Humid areas are indicated in Exhibit 13-1.

(g) Water Coils. Water cooling coils shall be certified in accordance with ARI STD 410-64. In lieu of ARI certification, the manufacturer shall submit a written certification from a nationally-recognized independent testing firm to verify coil performance when tested according to ARI STD 410-64 testing procedures.

(h) Fire Protection.

(1) The current requirements of NFPA 90A and 90B will be incorporated in all heating and air conditioning system designs. Corridors shall not be used as supply, return or exhaust air plenums.

(2) In existing structures, corridors may be used as return air plenums where there are no feasible means to install return air ducts.

(i) Duct Work. Duct work shall be designed in accordance with applicable SMACNA standards and ASHRAE recommendations. Fibrous glass ductwork shall not be used.

(j) Year-Round Cooling Requirements. If an air conditioning system serves areas which have high internal heat gains, such as electronic equipment areas, consideration must be given to possible year-round cooling requirements, and the system must be designed accordingly. This will include provisions for low ambient operation of air-cooled condensers or the use of outside air economizer cycle. Provisions for reheating of supply air should be provided where justified.

(k) Ventilation.

(1) Equipment Rooms. Mechanical ventilation shall be provided to limit air temperature rise to 10 F in unoccupied equipment rooms. Normally occupied areas shall be spot cooled as required. Control rooms, etc., shall be air conditioned. Some air conditioned equipment rooms such as control, electrical switchgear, or computer rooms, even though they are unoccupied, will require 100 percent backup where economically justified or required by design criteria.

(2) Hazardous Areas. The exhaust system discharge point shall be such that the vapors cannot enter other areas through open windows or the fresh air system. The capacity of the exhaust system shall be sufficient to prevent flammable or toxic vapors from escaping into surrounding hazardous areas. Direct recirculation shall not be permitted. Mechanical ventilation and exhaust systems for flammable and toxic gases shall follow the codes of practice of the National Fire Protection Association, TM 5-810-1, Industrial Ventilation, and the ASHRAE Guide and Data Books.

(3) Special Process Spaces. Special process areas require a greater degree of ventilation to remove dust, fumes, gases, or vapors harmful to personnel. Therefore, special consideration shall be given to these areas, and the ventilation system shall be designed, installed, and protected in accordance with ASHRAE Handbook and Industrial Ventilation.

(4) Special Buildings. Ventilation requirements for special buildings will be evaluated, and recommendations and calculations will be submitted for approval to the COE prior to commencement of design.

(l) Heating.

(1) Outside Design Conditions. Outside heating design conditions for Army and Air Force installations are listed in Exhibit 13-1.

(2) Inside Design Conditions. Unless stated otherwise the inside design temperatures shall be determined as follows:

70 degrees F	Living and administrative areas (inactive employment)
55-65 degrees F	Working areas (active employment)
40 degrees F	Storage areas to prevent freezing

(3) Boilers. Boilers shall be designed, constructed, tested, and installed in accordance with the ASME Boiler and Pressure Vessel Code, Section IV. Design pressures shall be 15 psig or less for steam boilers and 50 psig or less for hot water boilers. Boiler trim shall include safety valves, stop valves, water column, blow-off valves, piping and tank, low water cutoff, flame safety system, and control panel.

(4) Feedwater Heaters. Feedwater heaters such as deaerators, shall be designed, constructed, tested, and installed in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII.

(5) Fuel Oil Burning Equipment and Fuel Oil Storage Tanks. This equipment and tanks shall be in accordance with NFPA Pamphlets 31 and 54, respectively. All underground fuel oil tanks shall be double wall with leak detection system. A monitoring well system shall be provided if the fuel oil tank is in ground water.

(6) Gas-firing Equipment. This equipment shall be in accordance with NFPA Pamphlet 54.

(7) Heat Pumps. Heat pumps should be considered for facilities that are air conditioned. Heat pumps shall be justified by an economic analysis in accordance with Chapter 20, titled ENERGY AND ECONOMIC STUDIES.

(8) Electric Resistance Heating. For space heating or reheat for personnel comfort applications is prohibited, except for unusual situations where a waiver may be justified by an economic analysis in accordance with Chapter 20, titled ENERGY AND ECONOMIC STUDIES. Supplemental resistance electric heaters used in connection with unitary air-to-air heat pumps are permitted.

(m) Piping, Valves, and Fittings.

(1) Refrigerant piping.

This shall be designed in accordance with the ASHRAE Handbooks. Special care in designing suction lines shall be taken to ensureoil return and to prevent liquid carry-over to the compressor. Where an optional refrigeration piping is allowed, design of piping for all options shall be provided. Hot gas discharge lines shall be designed to ensure oil return. Oil separators shall be provided as required.

(2) Water distribution piping.

a. System layout. Interior piping shall be self-balancing, to the greatest extent possible, by using reverse return systems. Reverse return systems shall be looped to minimize the amount of pipe required.

b. Balancing. At every point where balancing is required, a flow sensor plus a balancing valve (or a combination unit) shall be specified and shown on the plans. The required length of straight pipe before and after the flow sensor shall be clearly shown on the plans.

c. Water velocity in medium and small diameter water piping generally shall not exceed 8 feet per second and shall be sized for friction loss not to exceed 4 feet per 100 feet.

d. An air separator and an expansion tank shall be installed in the main line of all systems.

e. Multiduty valves and fittings, such as combination shutoff/check/balancing valves at pump discharges and combination suction diffuser/strainers at pump inlets, shall be used where they can simplify piping and reduce costs.

f. For maintenance purposes, isolation valves shall always be used for isolating equipment from the system.

(o) Chilled and Dual Temperature Water Distribution Systems. The contract drawings shall show the general arrangement of piping, sizes, grades, thrust block, and other details. Analyses shall be made to determine the most economical thickness of insulation for the supply and return lines. The systems will generally be composed of factory fabricated preinsulated conduit sections.

(1) Thermal expansion. Thermal expansion must be considered and accounted for in straight runs of high temperature piping. All lines above ambient temperature must be considered, and calculations for lines above 160 degrees F must be included in the design analysis. Allowable stress ranges are given in ANSI B31.1.

(2) Anchors. Anchors shall be required where there is a change in direction, diameter, or wall thickness of a pipeline that may cause undesired movement, loads, or stress and whenever buckling of the pipe may occur. For buried piping, no credit may be taken for resisting friction between the pipe and the soil since the full development of this force does not occur when line movement is prevented. Anchors may be concrete or piling type.

(p) Mechanical Equipment Spaces. Mechanical equipment sized from three manufacturers, piping, and accessories in boiler and equipment rooms will be drawn to scale in both plan and elevations. Adequate space will be provided for maintenance, operation, and replacement of equipment, piping, and accessories. Catwalks, ladders, platforms, access panels and doors required for operation and maintenance of equipment, valves, and accessories will also be indicated and detailed on the drawings.

(q) Other Systems. Other systems are required for special projects such as medical and industrial facilities. These will be designed in accordance with the SOW for each project of this type.

(r) Equipment Schedules. Equipment schedules are required for all HVAC equipment. The schedule shall be presented in tabular form.

(s) Coordination Check. A cross check shall be made by designers of the structural, process piping, heating and ventilation, conveyor, and packaged equipment systems in order to detect and correct interferences with illumination levels, electrical raceways, fire detection, alarm and suppression systems, toxic or explosive detection systems, personnel, fire doors and shutters, and material and equipment traffic or other degradations of personnel or property safety. A check shall be made to ensure that no ducts or piping cross over or under electrical panels or switchboards (i.e., the "dedicated electrical space"). See Chapter 17, titled ELECTRICAL POWER, LIGHTING, AND GROUNDING for definition of "dedicated electrical space." The dedicated electrical space shall be clearly marked on the mechanical drawings.

(t) Insulation. Use only cellular glass insulation on chilled water piping.

(u) Controls. Most bases have in place Direct Digital Control (DDC) systems. The designer shall contact the base to insure the new controls are equal to or can seamlessly interface with the existing system.

13.9.3 Seismic Protection.

All piping, equipment, and utilities for jobs located in seismic zones must be protected in accordance with TI-809-04.

13.10 ENGINEERING WEATHER DATA.

ENGINEERING WEATHER DATA Data extracted from AFM88-29

LOCATION	NORTH LAT	WINTER-HEATING[1] DESIGN DRY BULB 99%	WINTER-HEATING[1] DESIGN DRY BULB 97-1/2%	HEATING DEGREE DAYS	SUMMER DESIGN DATA-DEGF 1% DES[2,3] db	1% DES[2,3] mcwb	2-1/2% DES[2] db	2-1/2% DES[2] mcwb	WET BULB[4] 1%	WET BULB[4] 2-1/2%	COOLING DEGREE DAYS
Anniston	33 - 37'	18	22	2806	97	77	94	76	79	78	1866
Arnold EDC	35 - 23'	11	16	3883	91	74	89	73	77	76	1212
Birmingham	33 - 37'	17	21	2844	96	74	94	75	78	77	1928
Ft Clayton[5]	8 - 59'	72	73	0	91	80	90	80	81	80	6003
Cape Can[5]	28 - 29'	35	38	711	90	78	88	78	80	79	2813
Columbus AFB	33 - 39'	15	20	2890	95	77	93	77	80	79	2039
Eglin AFB[5]	30 - 29'	25	29	1658	93	77	91	77	81	80	2620
Ft Gulick[5]	9 - 19'	72	73	0	88	80	87	80	82	81	6003
Gunter AFB[5]	32 - 24'	21	25	2153	95	77	94	77	80	79	2489
Holston AAP	36 - 31'	11	16	3695	93	73	91	73	76	76	1235
Homestead[5]	25 - 29'	43	47	218	90	78	89	78	80	79	3906
Howard AFB[5]	8 - 55'	72	73	0	89	79	88	79	81	80	5851
Hurlburt AFB[5]	30 - 26'	26	28	1782	92	78	90	78	81	80	2370
Jackson, MS[5]	32 - 19'	21	25	2300	97	76	95	76	79	78	2321
McDill AFB[5]	27 - 51'	37	40	560	92	77	91	77	80	79	3493
Maxwell AFB[5]	32 - 23'	21	25	2153	95	77	94	77	80	79	2489
Ft McClellan	33 - 43'	18	22	2806	97	77	94	76	79	78	1866
Memphis,TN	35 - 03'	13	18	3227	98	77	95	76	80	79	2029
Meridian	32 - 20'	19	23	2388	97	77	95	76	80	79	2231
Milan AAP	35 - 54'	11	16	3685	99	76	96	76	80	79	1637
Mobile[5]	30 - 41'	25	29	1684	95	77	93	77	80	79	2577
Montgomery[5]	32 - 18'	22	25	2269	96	76	95	76	79	79	2238
Patrick AFB[5]	28 - 14'	39	43	452	90	78	88	78	80	80	3405

Pensacola[5]	30 - 21'	26	30	1654	92	78	91	78	81	80	2642
Redstone Ars	34 - 39'	11	16	3302	95	75	93	74	78	77	1808
Ft Rucker[5]	31 - 16'	25	27	1968	94	76	92	76	80	79	2386
Tyndall AFB[5]	30 - 04'	29	33	1413	92	78	90	77	81	80	2737

Design Notes:

[1]Heating:	NC - 97-1/2% db 100% O.A. system - 1% db; 1% mcwb C - 99% db
[2]Air Conditioning: (Normal Design)	NC - 2-1/2% db; 2-1/2% mcwb 100% O.A. system - 1% db; 1% mcwb C - 1% db; 1% mcwb
[3]Air Cooled Condensers:	NC - 1% db C - 1% db
[4]Cooling Towers and Evaporative Condensers:	NC - 2-1/2% wb C - 1% db Approach - 7 f db
[5]Air Conditioning: (Humid Areas)	NC - 2-1/2% db; 1% mcwb 100% O.A. system - 1% db; 1% mcwb C - 1% db; 1% wb

These are minimum design conditions for sizing air cooled condensers and cooling towers. Oversizing condensers and cooling towers by specifying higher design conditions may be allowed for energy savings as determined by designer to obtain energy budget goals, and to provide additional owning and operating savings as established by a 25-yr life cycle analysis.

Legend:

NC - Noncritical (normal comfort air-conditioning)
C - Critical (see appropriate criteria)
db - dry bulb
wb - wet bulb
mcwb - mean coincident wet bulb

CHAPTER 14

FIRE SUPPRESSION SYSTEM

INDEX

CHAPTER 14

FIRE SUPPRESSION SYSTEM

14.1 GENERAL.

14.1.1 Scope.

This Chapter provides guidance for preparation and development of the fire suppression systems. Specific design submittal requirements in this chapter supplement the requirements in Chapter 1,titled GENERAL INSTRUCTIONS. All required documents, including drawings and design analysis, shall be in accordance with Chapter 2, titled PRESENTATION OF DATA.

14.2 APPLICABLE PUBLICATIONS.

The publications listed below, but referred to thereafter by basic designation only, form a part of this Manual. These publications are supplemented by the Corps of Engineers Guide Specifications (CEGS) to form design criteria.

Lead Design Manual:

AEI	Architectural and Engineering Instructions, Design Criteria

Supplimental Air Force Design Manuals:

MIL-HDBK-1190	Facility Design Guide

Military Handbook:

MIL-HDBK-1008C	Fire Protection for Facilities Engineering, Design & Construction

National Fire Protection Association (NFPA) Standards:

Latest Edition	National Fire Codes

National Fire Protection Association (NFPA) Standards:

Latest Edition	National Fire Codes

Guide Specifications:

SECTION 13920	Fire pumps
SECTION 13930	Wet pipe sprinkler systems, fire protection
SECTION 13935	Dry pipe sprinkler systems, fire protection

SECTION 13945	Aqueous film-forming foam (AFFF) fire protection system
SECTION 13965	Wet chemical fire extinguishing system

14.3 PROJECT DEFINITION (10-15%).

14.3.1 General Considerations.

(a) At the Project Definition phase the designer must define the customer's requirements and confirm that they can be met within the project's constraints. To that end, a comprehensive interface with the customer is required generally through a charrette or other previously approved data gathering process. The primary purpose of the design process at this stage is to gather any information from the customer that would be necessary in the design of the facility.

(b) The general fire suppression system type and purpose along with an order-of-magnitude estimate of major equipment sizes will be provided at the Project Definition phase for use in preparing of cost estimate and sizing the required mechanical spaces.

14.3.2 Project Definition Narrative.

The Project Definition narrative shall include, but not be limited to, the following items as applicable:

(a) List all references used in the Project Definition design including Government design documents, industry standards, safety manuals, criteria given to designer at the Charrette or predesign meeting.

(b) Explain proposed type of the fire suppression system.

(c) Describe any demolition required.

(d) List any environmental concerns and actions to be taken to address them.

14.4 CONCEPT DESIGN (30-35%).

14.4.1 General Considerations.

(a) At the Concept design stage of project development, it is recognized that all calculations are preliminary for analysis purposes and only indicate approximate capacities of equipment; however, calculations must be adequate to determine whether fire pumps and/or storage tanks are required. Any dimensions and sizes required are order-of-magnitude figures, conversationally stated, to assure adequate space for installation and maintenance of equipment and utility elements such as piping in congested areas.

(b) Equipment shown in plans and sections is not shown in great detail but is shown merely as simple geometric forms with approximately correct dimensions.

(c) Piping layouts shown are simple main pipe runs showing general location, routing and, when applicable, approximate order-of-magnitude sizes.

(d) Schematic diagrams are simplified. System flow diagrams, layouts, and one of each type of take-off, branch, or feed must be shown but not all individual branches. The purpose of the schematic is only to show system design intent and the basic principle of system operation.

(e) Drawings and sketches. Scale of concept drawings will generally be smaller than the working drawings. Plans and sections need be only large enough to properly show pertinent information. Sketches, neatly drawn, will be acceptable when sufficient to show pertinent information or to convey basic system concepts. Quantity of concept drawings are to be kept to the minimum number required to convey basic systems information. Some mechanical information required in the Concept submission may logically be included on other discipline drawings or in sketch form in the design analyses and need not be completed on formal drawings.

14.4.2 Concept Design Analysis.

The Concept Design Analysis shall include, but not be limited to, the following items as applicable:

14.4.2.1 Fire Suppression System.

(a) List all references used in the Concept design including Government design documents, industry standards, criteria given designer at predesign meeting, etc.

(b) Classify each building in accordance with the following:

(1) Fire zone

(2) Building floor areas

(3) Height and number of stories

(c) Discuss and provide description of required fire protection including extinguishing equipment, detection equipment, alarm equipment, and water supply.

(d) If water sprinkler systems are to be provided, preliminary hydraulic calculations shall be prepared for the most hydraulically demanding area to insure that flow and pressure requirements can be met with current water supply. Information on water supply available for fire protection will generally be provided by installation personnel through "Fire Flow Test" data. See Chapter 8, titled WATER, WASTEWATER, AND ENVIRONMENTAL PROTECTION.

(e) Identify any special security requirements.

14.4.2.2 Specifications.

Provide a basic outline in accordance with Chapter 3, SPECIFICATIONS.

14.4.3 Concept Drawings.

The Concept design drawings should include, but not be limited to, the following items as applicable:

14.4.3.1 Fire Suppression System.

Prepare a plan for each floor of each building that presents a compendium of the total fire protection features being incorporated into the design. Provide the following types of information:

(a) The location and rating of any fire-resistive construction such as occupancy separations, area separations, exterior walls, shaft enclosures, corridors, stair enclosures, exit passageways, etc.

(b) The location and coverage of any fire detection systems.

(c) The location and coverage of any fire suppression systems (e.g., sprinkler risers, standpipes, etc.).

(d) The location of any other major fire protection equipment.

(e) Indicate any hazardous areas and their classification.

(f) Provide description of type sprinkler system to be provided (e.g., dry pipe, preaction, wet pipe, AFFF, etc.).

(g) Address security requirements (e.g., dielectric couplings, grounding, etc.).

14.5 INTERIM DESIGN (50-60%).

In addition to the following items, the designer shall incorporate or answer all comments received from Corps of Engineers and Using Agency personnel concerning Concept submittal.

14.5.1 Interim Design Analysis.

The Interim Design Analysis shall include all items in the Concept design analysis and any necessary revisions. In addition, the following specific items shall be included when applicable:

14.5.1.1 Fire Suppression System.

Provide a detailed description of the system and its controls such as activation of system, interlocks with HVAC system and connection to detection and alarm systems.

14.5.1.2 Specifications.

The outline specifications previously submitted for the Concept design shall be revised, updated, further developed and resubmitted in accordance with Chapter 3, titled SPECIFICATIONS.

14.5.2 Interim Drawings.

The Interim drawings should show all information given on the concept drawings but in greater detail. In addition, the Interim drawings should include, but not be limited to, the following items as applicable:

14.5.2.1 Fire Suppression System.

(a) Include items shown on the concept drawings and any necessary revisions.

(b) Prepare a schedule describing the system with the following information: fire hazard and occupancy classifications, building construction type, GPM/square foot sprinkler density, area of operation, hose stream allowances and other as required.

(c) Provide detail of suppression system interface with HVAC, detection, or alarm systems.

(d) Provide one set of black line drawings showing a rough layout of the main piping involved in the sprinkler system. All piping, with the exception of branch lines, should be indicated and roughly sized. These drawings are for estimating purposes only. Do not indicate piping on the actual drawings.

14.6 FINAL DESIGN (Unreviewed 100%).

In addition to the following items, the designer shall incorporate or answer all comments received from the COE and customer concerning Interm submittal.

14.6.1 Final Design Analysis.

The Final Design Analysis shall include all of the information required in the Interim submittal in its final form and the information listed below when applicable:

14.6.1.1 Fire Suppression System.

(a) Incorporate or answer all comments received from the COE or the customer.

(b) Verify water supply through fire flow tests or otherwise. See Chapter 8, titled WATER, WASTEWATER, AND ENVIRONMENTAL PROTECTION.

14.6.1.2 Specifications.

(a) Marked-up draft specifications shall be submitted in accordance with Chapter 3, titled SPECIFICATIONS. Specifications used shall be those acquired subsequent to the Interim submittal.

(b) Specifications for fire suppression systems shall be performance type, except when aircraft hangars require specifically-designed sprinkler systems, listing hazards, minimum water densities, miminum area of operation, waterflow test data and any other data necessary for the construction contractor to design the system.

14.6.2 Final Drawings.

The Final drawings for sprinkler systems should be in a Ready-to-Advertise state which should include, but not be limited to, the following items as applicable.

14.6.2.1 Fire Suppression System.

(a) Include plans in final condition.

(b) Complete all legends and schedules.

(c) Complete all narratives, notes and title blocks as necessary.

(d) Provide one set of black line drawings for estimating purposes as described in the Interim submittal requirements.

14.7 READY-TO-ADVERTISE (100%).

The comments generated concerning the Final submittal shall be incorporated in the documents before they are submitted as Ready-to-Advertise.

14.7.1 Specifications.

The designer shall prepare the final detailed Technical Provisions of the specifications in accordance with Chapter 3, titled SPECIFICATIONS.

14.8 TECHNICAL REQUIREMENTS.

14.8.1 General Considerations.

(a) Coordinate space requirements, foundations, supports, pipe routing, electrical service, and the like for mechanical items with architectural, structural, and electrical design elements. Coordinate exterior mechanical distribution systems with design elements handling other exterior utility designs and site work.

(b) Standard or "packaged" equipment shall be used to the greatest extent possible to simplify specifying, purchasing, installation, and maintenance of equipment.

(c) AEI, Design Criteria, is the prime design manual. For Air Force projects, MIL-HDBK-1190 supplements it. For Army projects various manuals in the TM 5-810 series supplement it. In case of conflict, the AEI, Design Criteria governs. If unable to determine, contact the Mobile District Mechanical Section (CESAM-EN-DM).

14.8.2 Fire Suppression System.

(a) Criteria. The use of fire suppression systems shall be governed by the requirements of the AEI, Design Criteria, Mil Handbook 1008C and Mil Handbook 1190. Where systems are required they shall be designed in accordance with the applicable NFPA standards.

(b) Fire Protection. Fire protection that is cost-effective, yet provides maximum degree of protection consistent with the type and degree of fire exposure, shall neither be diminished in an effort to reduce project costs nor shall it be set aside for security or other considerations.

(c) Automatic Systems. Automatic fire protection systems shall be employed where suitable and cost-effective. Suffocating extinguishers should not be considered in conjunction with munitions or materials that contain their own oxygen supply.

(d) Low Maintenance. Automatic fire suppression systems, smoke evacuation systems, and other fire protection systems shall be designed so that their proper operation does not depend upon a high degree of sophisticated maintenance.

(e) Sprinkler Systems. Sprinkler systems will be performance-specified by the designer in compliance with Mil Handbook 1008C, NFPA 13, and the appropriate design manuals using the more stringent of the two in case of discrepancy. Preliminary hydraulic calculations shall be provided to insure that system demand does not exceed available supply. Plans developed shall indicate water densities, hazards, area of operation, waterflow test data, and any other data necessary for the construction contractor to design the system. The construction contractor will use the plans and specifications as a guide for subsequent preparation of detailed drawings which will be coordinated with requirements and options of the work of other trades required for construction of the facility. A note to this effect shall be placed on the plan. Riser locations shall also be shown on the plans.

(f) Accessibility Check. Designers shall check each system and its equipment to assure ready accessibility and operability of all maintenance points, gages, valves, controls, and signals. Devices whose operations are critical during emergency conditions shall be prominently located and singularly identified.

(g) Coordination Check. A cross-check shall be made by designers of the structural, process piping, plumbing, conveyor, and packaged equipment systems in order to detect and correct interferences with illumination levels, electrical raceways, fire detection, alarm and suppression systems, toxic or explosive detection systems, personnel, fire doors and shutters, and material and equipment traffic or other degradations of personnel or property safety. A check shall be made to ensure that no piping crosses over or under electrical panels or switchboards (i.e., the "dedicated electrical space"). See Chapter l7, titled ELECTRICAL POWER, LIGHTING, AND GROUNDING for definition of "dedicated electrical space." The dedicated electrical space shall be clearly marked on the mechanical drawings.

14.8.3 Seismic Protection.

All piping, equipment, and utilities for jobs located in seismic zones must be protected in accordance with TM 5-809-1.

CHAPTER 15

MECHANICAL - CENTRAL ENERGY SYSTEMS

INDEX

EXHIBITS

CHAPTER 15

MECHANICAL - CENTRAL ENERGY SYSTEMS

15.1 GENERAL.

Specific submittal requirements in this chapter supplement the requirements of Chapter l, titled GENERAL INSTRUCTIONS. All required documents, including drawings and design analysis, shall be in accordance with Chapter 2, titled PRESENTATION OF DATA.

15.1.1 Scope.

(a) Boiler Plants. The major requirements for the design of boiler plants (for individual buildings or central plants) producing steam at pressures above 15 psig are discussed in this chapter. Unless otherwise directed in this chapter, the design shall conform to the requirements of the ASME Boiler and Pressure Vessel Code including stamp, the ANSI Power Piping Code, and the applicable standards of the National Fire Protection Association.

(b) Air Pollution Control Equipment. The major requirements for the design of air pollution control equipment and for the preparation of air pollution permit applications are discussed in this chapter. The predicted air pollution emissions from each source shall comply with all applicable local, State, and Federal air pollution regulations. Unless exempted by the permitting agency, all actual emissions shall be proven to be in compliance by testing upon completion of construction. When investigating applicable regulations, particular attention shall be paid to determining if Prevention of Significant Deterioration of Air Quality (PSD) Regulations apply. Note that occasionally air pollution permits may be required even when no air pollution control equipment is required.

(c) Steam Distribution Systems. The major requirements for the design of steam distribution systems (above or below ground) are discussed in this chapter. The design shall conform to the ANSI Power Piping Code. Special instructions will be given the designer for the design of systems operating above 125 psig and 353 degrees F.

(d) Gas Distribution Systems. The major requirements for the design of underground distribution systems for natural or liquefied petroleum (LP) gas operating at pressures of 50 psig or less are discussed in this chapter. Unless otherwise directed in this chapter, the design shall conform to the requirements of TM 5-848-1 for natural gas and to the requirements of NFPA No. 58 for LP gas. Special instructions will be given the designer for the design of systems operating above 50 psig or larger than 4 inches in size.

15.2 APPLICABLE PUBLICATIONS.

The publications listed below, but referred to thereafter by basic designation only, form a part of this Manual. These publications are supplemented by references contained in the Corps of Engineers Guide Specifications (CEGS) to form design criteria.

Lead Design Manual:

AEI	Architectural and Engineering Instructions, Design Criteria

Supplemental Air Force Design Manuals:

MIL-HDBK-1190	Facility Design Guide

Department of the Army Technical Manuals (TM):

TM 5-810-15	Design of Coal Fired Boiler Plants
TM 5-848-1	Gas Distribution

Department of the Army Regulations:

AR 420-49	Heating, Energy Selection, and Fuel Storage, Distribution and Dispensing Systems

Guide Specifications:

SECTION 02552	Pre-engineered underground heat distribution systems
SECTION 02554	Aboveground heat distribution systems
SECTION 02555	Prefabricated underground heating/cooling distribution system
SECTION 02685	Gas distribution system
SECTION 02553	Heat Distribution systems in concrete trenches
SECTION 11250	Water softeners, cation-exchange (sodium cycle)
SECTION 11181	Incinerators, general purpose
SECTION 11182	Incinerators, medical waste
SECTION 11500	Air pollution control
SECTION 15555	Central high temperature water (HTW) generating plant and auxiliaries
SECTION 15559	Central steam-generating system, coal-fired
SECTION 15561	Central steam generating system - combination gas and oil fired
SECTION 15562	Heating and utilities systems, central steam

Federal Regulations:

Code of Federal Regulations, Title 40, "Protection of the Environment," Subchapter C, "Air Programs," Parts 50, 51, 52, 53, 60, and 61, Dated 1 July 1985

State Regulations:

Alabama Air Pollution Control Commission Rules and Regulations

Florida Administrative Code, "Rules of the Department of Environmental Regulation," Chapter 17-2, "Air Pollution," and Chapter 17-4, "Permits."

State of Mississippi, "Permit Regulations for the Construction and/or Operation of Air Emission Equipment."

Rules of the Tennessee Department of Public Health, Bureau of Environmental Health Services, Division of Air Pollution Control

American National Standards Institute (ANSI) Standards:

B31.1	Power Piping
B31.8	Gas Transmission and Distribution Piping Systems

American Society of Mechanical Engineers (ASME) Codes:

Section I	Power Boilers
Section VIII	Pressure Vessels, Division 1
Section IX	Welding & Brazing Qualifications

National Fire Protection Association (NFPA) Standards:

No. 31	Installation of Oil Burning Equipment
No. 54	National Fuel Gas Code
No. 58	Standard for the Storage and Handling of Liquefied Petroleum Gases
No. 85	Prevention of Furnace Explosions in Fuel Oil and Natural Gas-Fired Single Burner Boiler Furnaces
No. 85B	Prevention of Furnace Explosions in Natural Gas-Fired Multiple Burner Boiler Furnaces
No. 85D	Prevention of Furnace Explosions in Fuel Oil-Fired Multiple Burner Boiler Furnaces

15.3 PROJECT DEFINITION (10-15%).

15.3.1 General Considerations.

(a) At the Project Definition phase the designer must define the customer's requirements and confirm that they can be met within the project's constraints. To that end, a comprehensive interface with the customer is required generally through a charrette or other previously approved data gathering process. The primary purpose of the design process at this stage is to gather any information from the customer that would be necessary in the design of the facility. Also, the design preferences of the customer should be obtained for compliance if possible.

(b) The general mechanical system type and purpose along with an order-of-magnitude estimate of major equipment sizes will be provided at the Project Definition phase for the purpose of preparing the cost estimate and sizing the required mechanical spaces.

15.3.2 Project Definition Narrative.

The Project Definition narrative shall include, but not be limited to, the following items as applicable:

(a) List all references used in the Project Definition design including Government design documents, industry standards, safety manuals, criteria given to designer at the charrette or predesign meeting.

(b) Explain proposed type of the mechanical system.

(c) List the major equipment and give the sizes in general order-of-magnitude.

(d) Describe any demolition required.

(e) List any environmental concerns and actions to be taken to address them.

15.4 CONCEPT DESIGN (30-35%).

15.4.1 Concept Design Analysis.

The Concept Design Analysis shall contain all information or computations required to allow the reviewer to verify that the design complies with the design criteria, codes, and standards and is satisfactory for the intended purpose. It shall include, but shall not be limited to, the following:

(a) Boiler Plants.

(1) Detailed calculations for sizing major equipment, piping, breeching, fans, stacks, fuel tanks, coal and ash storage silos, deaerator, feed water heater, storage tanks, and other major items of equipment.

(2) Schematics for the control schemes used.

(b) Air Pollution Control Equipment.

(1) A 25-year life cycle cost analysis must be performed to determine the equipment and type of system to be installed. This analysis shall be performed in accordance with criteria set forth in Chapter 20, titled ENERGY AND ECONOMIC STUDIES. To prevent lost effort this analysis should be submitted for review **prior** to the concept submittal.

(2) Detailed calculations for sizing air pollution control equipment and related equipment.

(3) Schematics for control schemes used.

(4) Air pollution permit applications. Depending on the complexity

of the project the Concept submittal will include:

a. Permit application forms with all required data filled in; e.g., equipment capacities, emission rates, potential emissions, characteristics of control equipment, and backup data such as emission factors, emission calculations, and equipment manufacturer's guarantees or test data.

b. Discussions of Best Available Control Technology (BACT), good engineering practice as related to stack height calculations, and impact of emissions on visibility, soils, and vegetation.

c. Results of dispersion calculations (computer modeling).

d. Results of ambient air-monitoring.

(c) Steam Distribution Systems.

(1) Detailed calculations for determining sizes of steam and condensate lines.

(2) Preliminary calculations for determining sizes of expansion loops, ells, and "Z" bends.

(3) Site Classifications (Underground Water Conditions Classifications) for underground systems shall be made by the designer in strict accordance with Federal Construction Guide Specification FCGS 15705. This classification, along with all backup data and rationale, shall be submitted with the concept submission for approval. Unless stated otherwise in the SOW, The designer obtain soil boring data, giving underground water conditions and soil resistivity in Ohms/centimeter.

(d) Gas Distribution Systems. Detailed calculations for sizing gas lines.

15.4.2 Concept Design Drawings.

15.4.2.1 General Requirements:

(a) Provide a legend for all symbols and abbreviations. A legend for all symbols and abbreviations shall be included on the first drawing of each series of drawings. The legend shall apply to its respective series only.

(b) Equipment schedules shall be shown in their final form with preliminary equipment data filled in. Each series of drawings shall be provided with an equipment schedule. This schedule shall be placed on the first drawing in each series of drawings. The equipment schedule shall apply to its respective series only.

(c) Show points of connection to existing distribution systems, equipment, piping, and breeching.

15.4.2.2 Specific Requirements:

(a) Boiler Plants:

(1) Provide plan views at different levels through the boiler plant. The size and complexity of the job will determine the number of plan views.

Give major dimensions on all plan views. Show major items of equipment, major piping, breeching, combustion air ducts, coal, and ash handling equipment where appropriate.

<u>EXAMPLE</u>: A coal-fired spreader stoker or pulverized coal-fired plant would require, as a minimum, the following plan views showing major items of equipment and main piping headers:

a. Mechanical site plan.

b. General arrangement mechanical floor plan.

c. Piping plan at the lower plant level.

d. Piping plan at the operating floor level.

e. Piping plan at the mezzanine level.

f. Piping plan at the upper drum level.

g. Ash piping plan at the lower plant level.

h. Plan view of coal handling and storage equipment.

i. Plan view of the ash removal and storage equipment.

j. Plan view of all air pollution control equipment.

(2) Elevations or sections through the boiler plant showing all major items of equipment.

(3) Elevations showing all major items of equipment outside of the boiler plant.

(4) Piping 3 inches and larger shall be drawn with double lines. Piping smaller than 3 inches shall be drawn with single lines.

(5) Give a flow diagram for coal and ash handling equipment.

(6) Locate and size stack, showing height and material of construction.

(b) <u>Air Pollution Control Equipment</u>.

(1) Air pollution control equipment shall be shown in the overall plans and elevations of the project. The location, arrangement, capacity, and space requirements of all air pollution control equipment, auxiliary equipment, ductwork, and major piping shall be indicated. Partial plans and/or elevations of areas immediately surrounding air pollution control equipment shall be used if necessary. Major dimensions shall be shown.

(2) Include flow diagrams of all air pollution control systems.

(c) <u>Steam Distribution Systems</u>.

(1) Steam distribution system drawings should be grouped together and placed in the front of the project with the other utility drawings. Steam

distribution drawings should be given SD for sheet reference numbers.

(2) An overall site plan showing the entire system with all lines sized.

(3) Plan views for underground systems must show the following as minimum:

(a) Location of all lines.

(b) Location of all manholes.

(c) Location of all expansion loops.

(d) Location of expansion joints.

(e) All buildings, roads, railroads, sidewalks, parking areas, aboveground power lines, and all other structures, facilities, and fences.

(4) Plan views of the entire aboveground systems must show the following as a minimum:

a. Location of all lines.
b. Location of all overhead crossings.

c. Location of all expansion loops and anchors.

d. All buildings, roads, railroads, sidewalks, parking areas, aboveground power lines, and all other structures, facilities, and fences.

e. All steam and condensate lines should extend one foot inside of all buildings.

(d) Gas Distribution Systems.

(1) Building service lines and minor extensions of existing systems can be shown on the utility drawings.

(2) Plan view of all lines showing building served, point of termination at the building and point of connection to the existing system.

(3) Sizes of all lines must be given whether new or existing.

(4) Plan views must show all buildings, structures, sidewalks, streets, railroad crossings, parking areas, fences, and all other structures.

(5) Show location and size of all new valves and existing valves in existing lines.

15.5 INTERIM DESIGN (50-60%).

15.5.1 Interim Design Analysis.

15.5.1.1 General Requirements.

The Interim Design Analysis shall contain the following information:

(a) All of the information required in the Concept submittal in its final form including any revisions or additional information required by the comments on the Concept submittal.

(b) Calculations used in sizing auxiliary equipment and piping.

(c) Information required to identify commercial models. Items of equipment which are selected based on particular commercial models shall be presented in the design analysis with the appropriate model numbers, copies of catalog data, and all other information required for complete identification. Other manufacturers' models which would be acceptable should also be listed. **No manufacturers' names or model numbers will be included on the drawings or in the specifications.**

(d) Schematic diagrams shall be included for proposed control systems. In addition to showing logic functions, these diagrams should indicate and name individual control components.

(e) For underground steam distribution systems, the detailed calculations for determining allowable heat losses and required insulation thicknesses for steam and condensate piping.

15.5.1.2 Specific Requirements.

(a) Boiler Plants.

(1) Calculations for sizing auxiliary equipment and piping such as fuel oil pumps, chemical feed pumps, air compressors and blow-down systems.

(2) Detailed calculations of thermal stresses in boiler plant piping.

(3) Schematics for combustion control and ash handling systems.

(b) Air Pollution Control Equipment.

(1) Calculations for sizing auxiliary equipment, exchangers, and auxiliary fans.

(2) Schematics for proposed control systems.

(3) The air pollution permit applications shall be in the final form for presentation to the permitting authority. They shall include any changes required as a result of the review of the previous submittal.

(c) Steam Distribution Systems.

(1) Underground Systems.

a. Detailed calculations of thermal stresses in pipe at all expansion loops, changes in direction, and in manhole piping.

b. Calculation of cold-spring for all expansion loops and changes in direction.

c. Calculations of thermal expansion when expansion joints are to be used.

(2) Aboveground Systems.

a. Detailed calculations of thermal stresses in pipe at all expansion loops, and changes in direction.

b. Calculation of loads to be supported at all support points and anchor points.

15.5.2 Interim Design Drawings.

(a) Boiler Plants.

(1) Plans shall be complete, showing location of all equipment, ductwork, piping, and accessories.

(2) Completed piping and instrumentation (P&I) drawings must be submitted.

(3) Completed flow diagrams for all systems must be submitted.

(4) Draw all required sections and elevations of the boiler plant and all equipment giving dimensions and elevations.

(5) All plans, elevations, and sections must be drawn to scale. Normally, a scale of 1/4 inch to the foot or 1:50 is appropriate.

(6) Detail major equipment and show schematic piping for such equipment as the boiler, condensate surge tank, deaerating feedwater heater, economizer, steam turbines, steam turbine-driven equipment, and other major items of equipment. These details shall be complete, showing and sizing all piping, pipe fittings, valves, thermometers, strainers, pressure gages, and all other items in the piping system.

(b) Air Pollution Control Systems.

(1) Completed piping and instrumentation (P&I) drawings must be submitted.

(2) Completed flow diagrams for all systems must be submitted.

(3) Draw all views, sections, and elevations of the air pollution control equipment required for complete clarity, giving maximum dimensions.

(4) All plans, elevations, and sections must be drawn to scale. Normally, a scale of 1/4 inch to the foot or 1:50 is appropriate.

(5) Provide sufficient details of the ductwork and piping arrangements at air pollution control equipment. Where piping is involved, provide piping schematics, sizing all pipe, showing and sizing all fittings, valves, strainers, thermometers, pressure gages and other components.

(c) Steam Distribution Systems.

(1) Underground.

a. Draw a profile of the entire steam distribution system locating in profile all manholes, expansion loops, sidewalks, streets, railroad crossings, parking areas, building entrances, and all existing and new utilities. Include sanitary sewers, storm drains, water lines, gas lines, underground electrical and underground communication lines.

b. Size all piping and expansion loops and draw them to scale on plan views and in profile. A schedule for the expansion loops shall be put on the drawings. This schedule shall include size of expansion loops and cold spring.

(2) Aboveground.

a. Draw a profile of the entire steam distribution system locating in profile all overhead crossings, expansion loops, sidewalks, streets, railroad crossings, parking areas, building entrances, overhead electrical, overhead communication lines and all other overhead interferences.

b. Size all piping and expansion loops and draw them to scale on plan views and in profile. A schedule for the expansion loops shall be put on the drawings. This schedule shall include size of expansion loops and cold spring.

(d) Gas Distribution Systems.

(1) Show all utilities which the new gas lines will cross; indicate whether they are new or existing.

(2) Give elevations of all utilities which gas lines will cross.

15.6 FINAL DESIGN (Unreviewed 100%).

The comments generated concerning the Interim design submittal shall be incorporated into the Design Analysis and drawings before they are submitted as final. In addition, the following items shall be included.

15.6.1 Specifications.

Provide completed job specifications in rough draft form in accordance with Chapter 3, titled SPECIFICATIONS.

15.6.2 Drawings.

(a) Boiler Plants.

(1) Complete all equipment schedules. The equipment schedules, along with details on the drawings, and the specifications must give adequate information, including capacities of equipment so that each item of equipment required for the job can be purchased.

(2) Draw complete and detailed control diagrams for the combustion control system and all other control systems.

(3) Draw a detail of the combustion control panel, giving location of all equipment which it is to contain.

(4) Draw complete schematic piping details for all equipment,

sizing all piping and showing all piping, pipe fittings, valves, strainers, thermometers, pressure gates, and all other items in the piping system.

(5) Detail method of installing insulation and weather protection (aluminum jacket) where required on all hot equipment including condensate surge tank, deaerating feedwater heater, induced draft fans, breeching, baghouse or electrostatic precipitators and all other large items of equipment.

(6) Detail and specify all equipment. Do not require the Contractor to design or verify locations of equipment. The designer should accomplish all required design.

(b) Air Pollution Control Systems.

(1) Complete all equipment schedules. The equipment schedules along with details on the drawings, and the specifications must give adequate information, including capacities of equipment so that each item of equipment required for the job can be purchased.

(2) Draw complete and detailed control diagrams for all control systems.

(3) Detail method of installing insulation and weather protection on all air pollution control equipment which requires insulation.

(4) Detail and specify all major and ancillary air pollution control equipment. Do not require the contractor to design or verify locations of equipment. All required design should be accomplished by the designer.

(c) Steam Distribution Systems.

(1) Underground.

a. Draw a plan and sectional view of each manhole on the entire job. Minimum scale for these plans and sectional views is 1/2 inch = 1'-0".

b. Detail anchors in manholes, building entrances, manhole entrances, flange connections for connecting FRP pipe to steel pipe, and other required details for a complete installation.

c. Detail accumulator and steam trap valving arrangement.

d. Detail road crossings and show where casings are to be used if top of conduit or FRP pipe has less than 4'-0" of earth cover.

e. Include general notes on drawings.

f. A manhole cover schedule giving size of manhole cover plates must be included on the drawings.

g. Piping 2 inches and larger in manhole detail shall be drawn with double lines. Piping 1-1/2 inches and smaller in manhole details shall be drawn with single lines.

(2) Aboveground.

a. Draw plan and elevation views of each road crossing detailing method of supporting steam and condensate lines.

b. Detail each type of pipe support, guide and anchor. Show on plan views and in profile where each type of pipe support, guide and anchor, is to be used.

c. Detail enlarged section of condensate line at each steam trap for returning trap discharge into condensate return system.

d. Detail structural supports for all steam and condensate lines.

e. Include general notes on drawings.

(d) Gas Distribution Systems.

(1) Detail road crossings if required.

(2) Detail railroad crossings.

(3) Detail each type of valve used. Detail support under valves. Detail valve boxes and reinforced concrete slab at the top of the valves.

(4) Plan view, piping schematic, and elevation must be drawn of each gas metering station and pressure regulating station.

(5) Detail river and/or creek crossings.

(6) Detail and locate flotation anchors on plan views where and if required.

(7) Detail or specify method for purging air from gas lines.

(8) Detail corrosion control test stations.

(9) Detail insulation flange assembly to electrically isolate sections of the gas line. Locate the insulation flanges on plan views.

(10) Detail pipe line markers and locate them on plan views.

15.7 READY-TO-ADVERTISE (100%).

The comments generated concerning the Final design submittal shall be incorporated into the Design Analysis, specifications, and drawings before they are submitted as Ready-to-Advertise.

15.8 TECHNICAL REQUIREMENTS.

15.8.1 Boiler Plants.

15.8.1.1 Fuel Considerations.

The boiler plant shall be designed to produce the required quantity of steam when using the fuel(s) designated by the designer. Where appropriate, the designer shall solicit chemical analyses and heating values of the fuel(s) to be used from the Defense Fuel Supply Agency.

15.8.1.2 Determining Plant Capacity.

(a) For additions to existing plants, the design criteria will normally dictate the required capacity.

(b) For replacement of existing plants, the new plant will have the same capacity as the existing plant unless otherwise stated in the criteria.

(c) For new plants, the capacity will be determined by data supplied to the designer at the time of design.

15.8.1.3 Determining Number and Size of Boilers.

The number and size of boilers shall be determined in accordance with the guidance in ETL 1110-3-256, paragraph 1f, "Boiler plants having multiple boilers."

15.8.1.4 Determining Types of Boilers.

(a) For light oil and/or gas.

(1) If the boiler output capacity is less than or equal to 10×10^6 Btuh, use a packaged, firetube, scotch-marine boiler.

(2) If the boiler output capacity is greater than 10×10^6 Btuh, use a packaged watertube boiler.

(b) For heavy oil or heavy oil and gas, packaged watertube boilers are preferred, but packaged firetube, scotch-marine boilers can be considered for capacities less than 10×10^6 Btuh.

(c) For coal.

(1) If the boiler output capacity is less than or equal to 10×10^6 Btuh, use a extended water-leg, firetube boiler on a field- erected, firebox-type base.

(2) If the boiler output capacity is greater than 10×10^6 Btuh, use a field-erected watertube boiler.

15.8.1.5. Boiler Construction and Performance.

Boiler construction and performance will be covered by the appropriate CEGS.

15.8.1.6. Combustion Equipment, Combustion Controls, and Combustion Safety Controls.

Combustion equipment, combustion controls, and combustion safety will be covered by the appropriate CEGS, and the types of controls shall be a listed in EXHIBIT 15-1.

15.8.1.7. Condensate Surge Tank.

Condensate surge tank shall be supplied to receive and store condensate from the heating system. The condensate surge tank shall be sized to store a 20-

minute operating supply of condensate at the boiler plant's maximum load continuous rating. All make-up water shall be added to the condensate surge tank.

15.8.1.8 Feedwater Heaters.

Feedwater heaters shall be designed in accordance with guidelines found in TM-810-15, paragraphs 7.2 and 7.3.

15.8.1.9 Boiler Water Treatment.

Boiler water treatment should be designed according to the guidelines of TM 5-810-15, paragraph 7.7.

15.8.2 Air Pollution Control Systems.

The technical requirements will be supplied as a supplement to this Manual for each specific project.

15.8.3 Steam Distribution Systems.

15.8.3.1 Sizing Steam and Condensate Lines.

(a) Steam: The steam line will be sized for a maximum velocity of **12,000 feet per minute** or a maximum pressure drop of **1 psi per 100 feet** of line, whichever results in the larger pipe diameter. The minimum size steam line that shall be used is 2 inches. The designer may use any suitable charts or equations in making these calculations as long as they are included in the design analysis.

(b) Condensate. The condensate line will be sized for a maximum velocity of **4 feet per second.** Fiberglass-reinforced pipe (FRP) shall not be used. For steel pipe, a friction coefficient for "old" or "corroded" pipe should be used. The minimum size steel condensate line that shall be used is **l-l/4 inches**. The designer may use any suitable charts or equations in making these calculations as long as they are included in the design analysis.

15.8.3.2. Pipe Expansion.

The expansion of supply pipes and steel return pipes shall be provided for by changes in the direction of the run of pipe, or by expansion loops except where special instructions are given to use expansion joints. Offsets and expansion loops shall be properly designed, in accordance with the stress limits indicated in ANSI Standard B31.1, for the type of pipe specified.

15.8.4 Gas Distribution Systems

15.8.4.1 Sizing Gas Piping.

All gas lines will be sized in accordance with TM 5-848-1; however, the minimum size for a service line will be 1 inch.

15.8.4.2 Flotation Anchors.

All gas lines shall be evaluated for the requirements of flotation anchors.

Combustion Controls/Combustion Safety Controls
for Various Fuels and Boiler Output Capacities

Fuel Coal	Fuel Heavy Oil or Heavy Oil and Gas	Fuel Light Oil and/or Gas	Boiler Capacity 10
N/A	3-Position Controls Automatic Recycling Combustion Safety Controls per FM Approval Guide	3-Position Controls Automatic Recycling Combustion Safety Controls per FM Approval Guide	2.5 - 5
Positioning Controls Boiler Limit Controls (See CE 301.27)	Positioning Controls Automatic Recycling Combustion Safety Controls per FM Approval Guide	Positioning Controls Automatic Recycling Combustion Safety Controls per FM Approval Guide	5 - 10
Positioning Controls Boiler Limit Controls (See CE 30l.27)	Positioning Controls Automatic Recycling per NFPA 85	Positioning Controls Automatic Recycling Combustion Safety Controls per NFPA 85	1 - 14
	Positioning Controls Automatic Non-Recycling per NFPA 85		14 - 25
Positioning Controls Boiler Limit Controls (See CE 30l.27)	Positioning w/O_2 Trim Automatic Non-Recycling per NFPA 85	Positioning w/O_2 Trim Automatic Recycling Combustion Safety per NFPA 85	25 - 45
Metering Controls Boiler Limit Controls (See CE 301.27	Metering or Positioning w/O_2 Trim Automatic Non-Recycling per NFPA 85	Metering or Positioning w/O_2 Trim Automatic Non-Recycling Combustion Safety Controls per NFPA 85	>45

EXHIBIT 15-1

CHAPTER 16

SPECIAL MECHANICAL SYSTEMS AND EQUIPMENT

INDEX

CHAPTER 16

SPECIAL MECHANICAL SYSTEMS AND EQUIPMENT

16.1 GENERAL.

Specific submittal requirements contained in this chapter supplement the requirements of Chapter 1, titled GENERAL INSTRUCTIONS. All required documents including drawings and design analysis shall be in accordance with Chapter 2, titled PRESENTATION OF DATA. Requirements of this chapter pertain to the following mechanical systems and equipment.

1. Special Purpose, Chemical, Gas and Process Piping
2. Diesel Engines For Generators and Fire Pumps
3. Material Handling Equipment
4. Cranes and Hoists
5. Elevators, Dumbwaiters and Escalators
6. Vehicle Lifts
7. Dock Levelers
8. Conveyors
9. Truck Scales
10. Vacuum Pumps
11. Door Operating Mechanisms
12. Machine Tool Equipment
13. Chemical Mixers
14. Storage Tanks
15. Petroleum, Oils and Lubricant (POL) Facilities/Automotive and Aircraft Fueling Systems
16. Rocket Propellant Storage and Distribution Systems
17. Hydraulic Fluid Power Systems
18. Mechanical Power Transmission Equipment
19. Dynamometers
20. Mobile Boat Hoist
21. Arresting Systems For Aircraft
22. Pressure Vessels

16.2 APPLICABLE PUBLICATIONS.

The following publications shall be used when preparing plans and specifications for special mechanical systems and equipment included in this chapter: (The current edition of all publications shall be used.)

General.

AEI	Architectural and Engineering Instruction, Design Criteria
Military Handbooks	
MIL-HDBK-1190	Facility Planning and Design Guide Noise
TM 5-805-4.	and vibration Control for Mechanical Equipment, Dated 16 September 1970.
ASME	American Society of Mechanical Engineers - Codes and Standards.

ANSI	American National Standards Institute Codes and Standards.
AWS	American Welding Society - Codes and Standards.
API	American Petroleum Institute - Standards and Publications.
NFPA	National Fire Protection Association-Codes.

Special Purpose, Chemical, Gas, and Process Piping

ANSI/ASME B31.1	Power Piping.
ANSI/ASME B31.3	Chemical Plant and Petroleum Refiner Piping.
TM 5-810-7/ AFM 88-12, Chap. 4	High-Pressure and Cryogenic Gas Systems

Cranes and Hoists

CMAA No. 70	Crane Manufacturers Association of America Specification for Electric Overhead Traveling Cranes.
CMAA No. 74	Crane Manufacturers Association of America Specification for Top Running Single Girder Electric Overhead Traveling Cranes.
HMI-100	Hoist Manufacturers Institute Specifications for Electric Wire Rope Hoist.
MMA	Monorail Manufacturers Association Specification for Underhung Cranes and Monorail Systems.

Elevators

ANSI.ASME A17.1	"Safety Code for Elevators and Escalators."

Vehicle Lifts

CE-R-10.3	"Motor Vehicle Lifts."

Storage Tanks

TM 5-848-2	Handling of Aircraft and Automotive Fuels
AFM 85-16	Maintenance of Permanently Installed Petroleum Storage and Dispensing Systems.
MIL-HDBK-1022	Petroleum Fuel Facilities.
API Standard 620	Recommended Rules for Design and Construction of Large, Welded, Low-Pressure Storage Tanks.

API Standard 650	Welded Steel Tanks for Oil Storage.
API Publication 1605	Installation of Underground Petroleum Storage Systems.
NFPA-30	Flammable and Combustible Liquid Code.
API Standard 653	Tank Inspection, Repair, Alteration, and Reconstruction.

Automotive and Aircraft Fueling Systems/Petroleum, Oils and Lubricant (POL) Facilities

TM 5-848-2	Handling of Aircraft and Automotive Fuels.
FM 10-68	Aircraft Refueling.
AFM 85-16	Maintenance of Permanently Installed Petroleum Storage and Dispensing Systems.
MIL-HDBK-1022	Petroleum Fuel Facilities.
CEGS-11140	Fueling System for Motor Vehicles, Service Station Type.
ANSI/ASME B31.1	Power Piping.
ANSI/ASME B31.3	Chemical Plant and Petroleum Refinery Piping.
NFPA-30	Flammable and Combustible Liquid Code.

Rocket Propellant/Unconventional Fuel Storage and Distribution Systems

AFM 91-13	Maintenance of Permanently Installed Storage and Dispensing Systems for Unconventional Fuels.
AFM 161-30	Chemical Rocket/Propellant Hazards.
AFSC DH1-6	System Safety (Air Force System Command).

Hydraulic Fluid Power System

NFPA	National Fluid Power Association Standards.
ANSI 93.1 thru 93.69	American National Standards Institute Fluid Power Standards.

Mechanical Power Transmission Equipment

SAE	Society of Automotive Engineers Standards.
AGMA	American Gear Manufacturers Association Standards.

Pressure Vessels

ANSI/ASME BPV-VIII	Boiler and Pressure Vessel Code Section VIII, Pressure Vessels.
ANSI/ASME BPV-IX	Boiler and Pressure Vessel Code Section IX, Welding and Brazing Qualifications
ANSI.ASME BPV-X	Boiler and Pressure Vessel Code Section X, Fiberglass - Reinforced Plastic Pressure Pressure Vessels.
ANSI/ASME B31.1	Power Piping.

Specifications

SECTION 11162	Loading dock leveler
SECTION 13080	Seismic protection for mechanical, electrical equipment
SECTION 13202	Fuel storage systems
SECTION 13420	Self-acting blast valves
SECTION 14210	Elevators, electric
SECTION 14240	Elevators, hydraulic
SECTION 14580	Pneumatic-tube system
SECTION 14601	Cranes, bridge and gantry, top running, 30-ton maximum capacity
SECTION 14602	Cranes, single-girder bridge, monorail and jib
SECTION 14630	Cranes electric overhead traveling, top running and underhung 30-ton max
SECTION 16263	Diesel-generator set stationary 100-2500 Kw, with auxiliaries
SECTION 16264	Diesel-generator set, stationary 15-300 Kw, standby applications

16.3 PROJECT DEFINITION (10-15%).

16.3.1 General Considerations.

(a) At the Project Definition phase the designer must define the customer's requirements and confirm that they can be met within the project's constraints. To that end, a comprehensive interface with the customer is required generally through a charrette or other previously approved data gathering process. The primary purpose of the design process at this stage is to gather any information from the customer that would be necessary in the design of the facility. Also, the design preferences of the customer should be obtained for compliance if possible.

(b) The general mechanical system types and purpose along with an order-of-magnitude of major equipment sizes will be estimated at the Project Definition phase for the purpose parametric cost estimate and required mechanical spaces.

16.3.2 Project Definition Narrative.

The Project Definition narrative shall include, but not be limited to, the following items as applicable:

(a) List all references used in the Project Definition design including Government design documents, industry standards, safety manuals, criteria given to designer at the charrette or predesign meeting.

(b) Explain proposed type of the mechanical system.

(c) Describe any demolition required.

(d) List any environmental concerns and actions to be taken to address them.

(e) Decribe proposed construction planning of mechanical system for alteration/modification project.

16.4 CONCEPT DESIGN (30-35%).

16.4.1 Concept Design Analysis.

The following specific items shall be included where applicable.

(a) A list of all special mechanical systems and equipment in the project.

(b) A list of criteria furnished by the OCE, and the codes, documents, and design conditions used. Reference to any authorized waiver of these criteria or codes.

(c) Logic establishing the need for the system. A life-cycle cost estimate for all systems considered and a statement of justification for selection of the final system.

(d) Preliminary sizes of equipment, piping, and space required for the equipment and distribution methods selected.

(e) A description of the proposed control system.

(f) Description, approximate capacity, and location of any special mechanical equipment such as elevators, cranes, lifts, etc.

(g) Description of the various types and quantities (supported by calculations as applicable) of POL products and their associated unloading, storage, and dispensing systems.

(h) Phasing.

16.4.2 Concept Design Drawings.

The following specific items shall be shown where applicable.

(a) Flow diagrams of all systems proposed. These diagrams shall be an accurate schematic representation of the system, showing all proposed equipment, piping, control valves, and primary control loops. In addition, the drawings shall indicate approximate capacities of equipment, flow rates in mains, branches, and outlets, direction of slope for pipe, and shall identify the location of equipment by building and room.

(b) Plans that are sufficiently complete to show the location and general arrangement of mechanical equipment and major piping. Piping may be shown with single lines.

16.5 INTERIM DESIGN (50-60%).

16.5.1 Interim Design Analysis.

The Interim Design Analysis shall include all items in the Concept Design Analysis and any necessary revisions. In addition, the following specific items shall be included when applicable:

(a) Detailed calculations for sizing equipment, engines, tanks, piping, control valves, pumps, cylinders, gears, etc.

(b) Detailed logic diagrams for control schemes used.

(c) Any other information or computation required to verify that the design complies with the design criteria, codes, and standards, and is satisfactory for the intended purposes.

16.5.2 Interim Design Drawings.

The following specific items shall be shown when applicable:

16.5.2.1 Flow Diagrams of All Systems.

These diagrams shall show all of the information given on the Concept drawings, but in greater detail. The diagrams shall include equipment capacities and power requirements, all piping sizes with flow rates indicated, all valves, piping specialties, instrumentation, and control devices.

16.5.2.2 Plans and Sections.

Layouts and details of the final version of the proposed system showing location, arrangement, capacity and space requirements of all equipment plus size, elevations, supports, product identification and direction of flow for all piping.

16.5.2.3 Equipment.

The drawings shall include space for rating data in tabular form for all items of equipment, with space reserved for designating the manufacturer and the model number, in anticipation of as-built drawings. Preliminary rating data shall be submitted for all items of equipment even though it is not mandatory that it be inserted in the equipment schedule at this stage. Equipment schedules shall be completed when final rating data are established but not later than the Final Review submission. Since equipment rooms, pads, and pits represent the most congested areas for both equipment and piping, the following guidelines should be followed when drawings are being prepared.

(a) Single-line piping layouts are not sufficient to adequately plan major installations and to check for interference.

(b) Only pipe 2-l/2 inches and smaller may be shown to scale by single-line layouts and symbols.

(c) All pipe 3 inches and larger shall be shown to scale by double-line layout.

(d) All pipe fittings and accessories for pipe 3 inches and larger shall be drawn to scale.

(e) All fittings shall be drawn to scale using double-line layouts.

(f) All equipment shall be outlined to scale, and maintenance or removal space shall be indicated.

(g) Removal, replacement, or moving space must be considered for the largest and heaviest equipment when a drawing is made.

(h) Complete, dimensioned, engineering drawings shall be prepared for all items in this section.

(i) In plans, sections, and details these same rules shall apply.

16.6 FINAL DESIGN (Unreviewed 100%).

The design analysis and the drawings submitted shall be complete. A section of technical specifications is required for each mechanical system or piece of equipment covered in this chapter.

16.7 READY-TO-ADVERTISE (l00%).

The comments generated concerning the Final design submittal shall be answered and incorporated in the documents before they are submitted as Ready-to-Advertise.

16.8 TECHNICAL REQUIREMENTS.

(a) The rotational speed of pumps shall not exceed l,800 rpm.

(b) The following technical requirements pertain to piping systems. Technical requirements for other special purpose equipment will be provided as required for each project.

16.8.1 Expansion.

16.8.1.1 Temperature Ranges.

When designing the flexibility of the piping system, full consideration shall be given to the maximum and minimum temperatures to which the line will be exposed. This shall include not only environmental temperatures but also temperatures of cleaning processes such as steam or vapor. Ample provision shall be made for temperature ranges and shall be completely covered by the Design Analysis. Generally, where expansion of piping will be absorbed by utilizing the inherent flexibility of the piping or by providing expansion loops and bends, the pipe expansion stresses shall be calculated by a standard method used in industry such as the Tube Turn, Blaw Knox, Grinnell, or M. W. Kellogg methods.

16.8.1.2 Piping Alignment.

The horizontal and vertical alignment of the piping shall be carefully planned to utilize the inherent flexibility of the pipe to absorb expansion. Obstructions such as road crossings, which may occur in the route of the piping, shall be given due consideration.

16.8.2 Supports.

Supports for aboveground piping shall be designed with full allowances for the movement and forces developed by the piping, either during cleaning, operation, testing or shock loading, whichever is the most severe condition, and shall be of ample strength to withstand the forces developed by the piping. All supports shall be designed to allow free movement of the piping during expansion and to adequately guide the line without binding it. Support design shall be stock or production parts, provided they conform to the requirements of design loads and are commonly used in good engineering practice. Accurate stress and weight balance calculations shall be made to determine forces and moments at each support point, anchor, and equipment connection. Vibration and shock loads shall be examined in detail and accommodated. Pipe supports shall be designed in accordance with MSS-SP-_______+________.

16.8.3 Anchors.

All pipe anchors shall be designed to completely withstand the maximum forces developed by the pipe system during the most severe condition of operation, either during regular operation, testing, shock loading, or cleaning. All anchors shall be of ample design and shall be proportioned to not less than twice the section modulus of the pipe. Design calculations for anchors shall be a part of the design analysis and should show all forces, assumptions, soil bearing values, etc. When it is necessary to use a bellows-type expansion device, anchors and supports shall be designed to take the full pressure thrust at the highest pressure to which the line will be subjected, either in normal operation or during the pressure testing, whichever is the most severe condition.

16.8.4 Piping Components.

Components such as valves, strainers, gages, and other devices shall be specified in detail with pressure or temperature rating, size, capacity, pressure and temperature ranges, test pressures, and materials called out.

16.8.5 Piping Materials.

The options on materials for the piping systems shall be furnished as part of the design criteria. Interface locations for optional pipe material shall be detailed on the drawings.

16.8.6 Welding Qualifications.

Welding shall be in accordance with the ASME Boiler and Pressure Vessel Code, ANSI/ASME B31.1 Power Piping Code; ANSI/ASME B31.3, Chemical Plant and Petroleum Refinery Piping Code; or the American Welding Society Standards. Requirements for welding procedure, welding operator, and welder qualification and identification shall be specified; no unqualified procedure or welder shall be used. Detailed requirements for welding shall be specified.

16.8.7 Protective Coatings and Insulation.

Protective coating for both aboveground and underground piping shall be specified with appropriate test procedures.

16.8.8 Seismic Design.

Design shall conform to the requirements of the Seismic Zone in which the construction is located.

16.8.9 Drainage and Sectionalizing.

All conditions of operation of the system shall be taken into consideration when designing the drainage points and sectionalizing. If a system is to be cleaned in place, the line shall be capable of being divided into short sections for ease of cleaning without having to cut the piping. Drains shall be located at all low points, and if they are to be used for cleaning or flushing, they will be of a size large enough to assure adequate flow of cleaning agents and rinses.

16.8.10 Cleaning.

The details of the cleaning processes and the number and location of cleanings shall be specified. The specification shall call out the degree of inspection and shall require the use of approved cleaning facilities. Detailed cleaning procedures shall be required of the Contractor prior to cleaning any piping. Shop cleaned pipe or components cleaned off the job will be required to be sealed against contamination with a substantial sealing method which will endure, without failure, the rigors of shipment, handling, and storage.

16.8.11 Testing and Inspection.

16.8.11.1 General Requirements.

Methods and degree of cleanliness and welding inspection shall be specified. Generally, welding inspections shall consist of visual and radiographic or other nondestructive inspection. The method of testing and the standards by which they will be judged shall be indicated.

16.8.11.2 Detailed Test Procedures.

Detailed test procedures shall be required for pressure, leak and operational/performance tests of all piping systems. All test requirements shall be specified in detail. In particular, for pressure testing, specify type of medium, pressure and duration of tests. For operational or performance tests, all aspects and modes shall be described using valve settings, pressures, flow rates, mediums and temperatures. Each test procedure shall specify the number of repetitions required and the corrective action to be taken. Performance tests for individual components of piping systems (i.e., pumps, valves, meters, filters, strainers, flow and pressure monitoring equipment, etc.) shall require certification from the manufacturer.

16.8.12 Piping Identification.

Requirements for piping identification shall be included in all specifications.

16.8.l3 POL Facilities.

POL facilities shall be designed in accordance with AEI, Design Criteria, TM 5-848-2, and MIL-HDBK-1022. Fuel oil supply shall be from an independent source for diesel driven emergency generators and fire pumps.

16.8.l4 Installation.

Detailed installation procedures for piping of different material shall be given in the respective specification and shown to scale on the drawings. The procedures shall include excavation, trenching, backfill for underground piping, sleeves for pipes, protective casings, joint preparation and details for laying pipe under loaded surfaces.

16.8.15 Engine-Generators.

Diesel engine-generators shall be designed in accordance with instructions given in applicable Guide Specification and the applicable portions of this text.

16.8.15.1 Facilities for Engine-Generators.

Engine-generator buildings or rooms designed for engine-generator installation shall be designed to support the unit with the following:

(a). Sufficient cooling and combustion air supply and exhaust.

(b). Correct air flow patterns to optimize cooling of both generator and engine.

(c). Door width and height to allow installation and removal of sets.

(d). Floor space for starting batteries, charger, and working space around the set, fuel oil supply and return piping trenches, day tank, electrical equipment, etc.

(e). Height of building to accommodate diesel engine, exhaust pipe, muffler and insulation. Materials should be selected for exterior piping to resist rusting, corrosion to prevent discoloration of the building exterior.

(f). Size of building roof framing to accommodate suspension or installation of engine exhaust system. Materials should be selected for exterior piping to resist rusting, corrosion, to prevent discoloration of the building exterior.

(g). Sufficient inside building temperature for engine to be maintained with jacket water heaters at required starting temperature.

A scaled drawing is required for all diesel-generator sets and shall show each set and the above-mentioned appurtenances.

16.8.16 Cranes and Hoists.

16.8.16.1 Hoists.

Hoists shall be shown on the drawings in both plan and elevation. The following items shall be shown to scale and dimensioned on the drawings:

1. Length, size and location of monorail.

2. Location, degree and radius of all monorail curves.

3. Location of all monorail track switches.

4. Minimum acceptable hook height; i.e., distance from finished floor to saddle of hoist hook in raised position.

These items can be shown on architectural, structural or on a separate mechanical drawing. If additional specifications are required, recognized standards, HM1-100 and MMA Specifications, for example, shall be used.

16.8.16.2 Overhead Traveling Cranes.

A crane clearance diagram is required for all overhead traveling cranes. The required limits of crane hook travel in both plan and elevation and the dimensions of an envelope reserved for installation of the crane shall be shown on the drawing. For envelope dimensions, an overhead clearance of 3 inches above the high point of the crane is satisfactory. Between the crane and the side walls of the building, a clearance of 4 to 6 inches is adequate. Details of special features, such as pickup beams, control outriggers, special hooks, trolleys, hoist, end trucks, etc., shall also be shown on this drawing.

16.8.16.3 Special Hoists and Cranes.

Special hoists and cranes that are not monorail or overhead traveling type shall be treated as special designs. Design requirements for these special cranes shall be requested through Project Management to the appropriate technical section at or before the predesign conference.

16.8.17 Equipment Foundations.

16.8.17.1

Reinforced concrete foundations for engine or gas turbine-driven generators, pumps, compressors, etc., shall be designed to have a mass twice as large as the equipment to be mounted on the foundation. This is a minimum requirement. Foundations for other equipment and special applications will be given individual consideration for stability, compression, tension and vibration and be addressed in the design analysis. Foundations for equipment that produces excessive or damaging vibration shall be isolated from building floor slabs or surrounding construction. Foundations for equipment that does not produce vibration shall be constructed in the same monolith with surrounding construction or be designed as an integral second pour to surrounding construction.

16.8.17.2

Reinforced concrete foundations for horizontal underground fuel tanks and waste oil tanks shall be sized to prevent buoyancy when an empty tank is completely submerged in water. Reinforced concrete foundations for vertical underground or semiburied and mounded-over fuel tanks shall be designed on an individual basis with consideration given to soil bearing loads, ground water elevations, structural support and connection of tank to foundation. Horizontal tanks shall be provided with sufficient straps or ties to fasten the tank to the foundation. All straps and ties used to secure tanks to foundations shall be connected to embedded members. All metal used for securing tanks to foundations shall be given a protective coating to arrest corrosion and provide cathodic protection.

16.8.17.3 Anchor Bolts.

Anchor bolts which are used to connect equipment to concrete foundations shall be located by template or other appropriate methods for the equipment supplied. All anchor bolts shall be appropriately located and the concrete placed around the anchor bolts during the construction of the foundation. Anchor bolts shall be designed to transfer all tension forces into the concrete when equipment is connected to foundations.

16.8.18 Storage Tanks for Petroleum, Oils, and Lubricants.

Tanks shall be vertical or horizontal and either aboveground or underground. For tanks with a volume of 40,000 gallons or less, preference shall be given to tanks of the shop-fabricated horizontal type. Tanks with volumes larger than 40,000 gallons shall be aboveground, vertical, fixed-roof with floating pan, as required by project criteria.

16.8.18.1 Aboveground Tanks (Army).

Tanks shall be designed in accordance with TM5-848-2, the latest editions of API-650 and NFPA-30. Tanks to be rehabilitated or modified shall be in accordance with API-653. All aboveground tanks shall have spillage containment dikes.

16.8.18.2 Aboveground Tanks (Air Force).

Tanks shall be designed in accordance with MIL-HDBK-1022, and the latest editions of API-650 and NFPA-30. All aboveground tanks shall have spillage containment dikes.

16.8.18.3 Underground Tanks (Army).

Tanks shall be designed in accordance with TM-5-848-2, Standard Drawings and NFPA-30. Tanks with volumes of 40,000 gallons or less shall be double-wall, horizontal and suitable for underground installation. Tanks shall be either of fiberglass reinforced plastic construction or of steel construction. Steel tanks shall be coal tar or epoxy coated and provided with a cathodic protection system or coated with glass fiber-reinforced polyester resin coating. All storage tanks shall be monitored by a leak detection system. The leak detection system shall indicate, by an audible alarm and indicator lights, the occurrence of a leak in any part of either tank shell. The system shall be of the electronic monitoring, pressure monitoring, vacuum monitoring, or liquid monitoring type. Observation wells shall be provided in areas of seasonal high groundwater where the tank is anchored in the groundwater during normal operation. The wells may employ any of the types of leak detectors mentioned above to provide continuous monitoring. All observation wells shall be clearly identified and provided with locking devices. Tanks with volumes of more than 40,000 gallons shall be vertical, and field erected unless otherwise authorized.

16.8.18.4 Underground Tanks (Air Force).

Tanks shall be designed in accordance with MIL-HDBK-1022 and NFPA-30. Tanks with volumes of 40,000 gallons or less shall be double-wall, horizontal and suitable for underground installation. Tanks shall be either of fiberglass reinforced plastic construction or of steel construction. Steel tanks shall be coal tar or epoxy coated and provided with a cathodic protection system or coated with glass Fiber-reinforced polyester resin coating. All storage tanks shall be monitored by a leak detection system. The leak detection system shall indicate, by an audible alarm and indicator lights, the occurrence of a leak in any part of either tank shell. The system shall be of the electronic monitoring, pressure monitoring, vacuum monitoring, or liquid monitoring type. Observation wells shall be provided in areas of seasonal high groundwater where the tank is anchored in the groundwater during normal operation. The wells may employ any of the types of leak detectors mentioned above to provide continuous monitoring. All observation wells shall be clearly identified and provided with locking devices. For tanks with volumes of more than 40,000 gallons, preference shall be given to vertical aboveground field erected unless otherwise authorized.

16.8.19 Test and Acceptance of Special Mechanical Systems and Equipment.

Test plans for each special mechanical system and the designer as a part of the applicable technical specification shall provide piece of equipment. The test plan shall contain a description of measurable parameters, required data, pass/fail criteria, repetitions of each test, accuracy’s, calibration requirements, method of analysis, test report formats, and required documentation for approval. Test plans shall require demonstration of operational capabilities at normal operating conditions and at test conditions. Action required and responsibility to adjust, repair, alter or replace each special mechanical system or piece of equipment, if test results show deviation from the construction contract requirements, shall be included in the test plans. The responsibilities of the construction contractor to develop, submit for approval, and perform detail test procedures that reflect requirements of each test plan shall be clearly defined.

CHAPTER 17

ELECTRICAL AND ELECTRONIC SYSTEMS

INDEX

EXHIBITS

CHAPTER 17

ELECTRICAL AND ELECTRONIC SYSTEMS

17.1 GENERAL.

17.1.1 Scope.

This chapter gives general guidelines for the preparation of drawings, specifications, and design analysis as related to power, lighting, grounding, and electronic systems. Specific submittal requirements in this chapter supplement the requirements of Chapter 1, GENERAL INSTRUCTIONS. All required documents, including drawings and design analysis, shall be in accordance with Chapter 2, PRESENTATION OF DATA.

17.1.2 Design Submittals.

The following submittal guidelines have been developed for the most common projects such as a building or buildings and minor exterior electrical design. Projects which require extensive exterior electrical work and projects with complicated or highly-technical interior electrical work will have special submittal requirements developed for that project.

The requirements shall be defined, developed and agreed upon at the predesign conference and will become part of the contract.

Design submittals will be reviewed for general compliance with criteria. Some detailed checks will be made. Complete and independent checking of the design should be accomplished by the designer. The designer is fully responsible for the design. The design should be complete and accurate. It should be thoroughly checked for errors, conflicts (both within and between disciplines), and proprietary requirements. No proprietary restrictions may be included in the contract unless specifically authorized.

17.2 APPLICABLE PUBLICATIONS.

17.2.1 American National Standard Institute (ANSI).

ANSI-C2	National Electrical Safety Code

17.2.2 Institute of Electrical and Electronic Engineers.

IEEE 142	Recommended Practice for Grounding of Industrial and Commercial Power Systems.

17.2.3 Instrument Society of America (ISA).

ISA 55.1	Instrumentation Symbols and Identification
ISA 55.2	Binary Logic Diagrams for Process Operations

17.2.4 National Fire Protection Association (NFPA).

NFPA 70	National Electrical Code (Latest Issue)
NFPA 70E (OSHA)	Electrical Safety Requirements for Employee Workplaces
NFPA 72	National Fire Alarm Code
NFPA 90A	Installation of Air Conditioning and Ventilating Systems
NFPA 101	Safety to Life from Fire in Buildings and Structures
NFPS 170	Fire Safety Symbols

17.2.5 National Association of Corrosion Engineers.

NACE RP0169	(Rev 1992) Recommended Practice. Control of External Corrosion on Underground or Submerged Metallic Piping Systems
NACE RP0188	Standard Recommended Practice Discontinuity (Holiday) Testing of Protective Coatings
NACE RP0285	Recommended Practice. Control of External Corrosion on Metallic Buried, Partially Buried, or Submerged Metallic Liquid Storage Systems
NACE RP0286	Recommended Practice. The Electrical Isolation of Cathodically Protected Pipelines.

17.2.6 National Electrical Manufacturers Association (NEMA).

NEMA E1 13	Pulse Initiators for Watthour and Other Integrating Meters

17.2.7 Military Handbooks.

MIL HDBK 419A	Military Handbook Grounding, Bonding and Shielding for Electronic Equipments and facilities
MIL HDBK 1190	Military Handbook for Facility Planning and Design Guide
MIL HDBK 1191	Military Handbook for Medical and Dental Treatment Facilities, Design and Construction Criteria Guide
MIL HDBK 1008C	Fire Protection for Facilities

17.2.8 Technical Manuals.

TM 5-809-10	Seismic Design for Building

TM 5-809-11	Design Criteria for Facilities in Areas Subject to Typhoons and Hurricanes
TM 5-8ll-l	Electric Power Supply and Distribution
TM 5-8ll-2	Electrical Design: Interior Electrical Systems
TM 5-8ll-3	Electrical Design: Lightning and Static Electricity Protection
TM 5-811-7	Cathodic Protection
TM 5-811-14	Coordinated Power System Protection

17.2.9 Miscellaneous References.

AEI	Architectural and Engineering Instructions, Design Criteria
ER 1110-345-700	Design Analyses, Chapter 1
AMCR 385-100	Safety Manual
ETL 1110-3-403	Electrical Power Systems for Non-Linear Loads
ETL 87-9	Prewiring
ETL 91-6	Cathodic Protection
ETL 96-1	fire Protection Criteria - New Aircraft Facilities
STD 40-06-04	Lighting Fixtures, Standard Detail No. 40-06-04 (http://www.hnd.usace.army.mil/techinfo/index.htm)
STD 40-06-05	Army Aviation Lighting Fixtures, Standard Detail No. 40-06-05
CFR 28 Part 36	Nondiscrimination on the Basis of Disability of by Public Accommodation and in Commercial Facilities, Final Edition (ADA)
FED-STD-795	Uniform Federal Accessibility Standards
AFM 85-5	Maintenance and Operation of Cathodic Protection Systems
AFM 91-24	Energy Management and Control Systems (UMCS (EMCS)'s)

17.2.10 Other Publications and Code Compliance.

In addition to the codes and standards listed above, all electrical work shall comply with the applicable requirements of the latest edition of the standards of the National Electrical Manufacturer's Association (NEMA);

Insulated Power Cable Engineer's Association (IPCEA); and all applicable federal, state, city, and local codes, regulations, ordinances, publications and manuals. All new manufactured equipment shall be listed by the Underwriter's Laboratory (UL) or a similar testing laboratory acceptable to COE. When codes conflict, the more stringent standard shall govern.

17.2.11 Guide Specifications.

CEGS-13080	Seismic Protection for Mechanical Electrical Equipment
CEGS 13110	Cathodic Protection System (Sacifical Anode)
CEGS 13111	Cathodic Protection System (Steel Water Tanks)
CEGS 13112	Cathodic Protection System (Impressed Current)
CEGS 13721	Small Intrusion Detection System
CEGS-13852	Fire Alarm Reporting System, Radio Type
CEGS-l6ll3	Underfloor Duct System
CEGS-l6ll5	Underfloor Raceway System (Cellular Steel Floor)
CEGS-16263	Generating Units, Diesel-Electric, Stationary l25-800 kW, With Auxiliaries
CEGS-16264	Generating Units, Diesel-Electric, Stationary l0-99 kW, With Auxiliaries
CEGS-l63ll	Main Electric Supply Station
CEGS-l6370	Electrical-Distribution; Aerial
CEGS-16375	Electrical Distribution Systems, Underground
CEGS-16410	Automatic Transfer [and By-Pass/Isolation] Switches
CEGS-16415	Electrical Work, Interior
CEGS 16475	Coordinated Power System Protection
CEGS 16525	Helipad Lighting and Visual Navigation Aids
CEGS 16526	Airfield and Heliport Lighting and Visual Navigation Aids
CEGS 16610	Uninterruptible Power System (UPS)
CEGS 16650	Electromagnetic (EM) Shielding
CEGS 16665	Static Electricity Protection System
CEGS-16670	Lightning Protection System (to be 13100)

CEGS-16721 Fire Detection and Alarm System, Direct Current Loop (to be 13850)

CEGS-16724 Fire Detection and Alarm System, Addressable Systems (to be 13851)

CEGS-16725 Intrusion Detection System (to be 13720)

CEGS-16740 Telephone System, Small

CEGS-16741 Telephone System, Inside Plant

CEGS-16742 Telephone System, Outside Plant

CEGS-16750 Nurse Call System

CEGS-16751 Closed Circuit Television Systems

CEGS-16752 Electronic Entry Control Systems

CEGS-16753 Wireline Data Transmission Media for Security Systems

CEGS-16754 Fiber Optics Data Transmission Media for Security Systems

CEGS-16755 Radio Paging System

CEGS-16760 Intercommunication System

CEGS-16770 Radio and Public Address Systems

CEGS-16781 Master Antenna Television System

CEGS-16790 Stand Alone One-Way Radio Control System

CEGS-16792 Wire Line Data Transmission System

CEGS-16794 Coaxial Cable Data Transmission Media

CEGS-16797 One-Way Radio Control/ Utility Monitoring and Control System (UMCS)

CEGS-16798 Two-Way Radio Data Transmission System

17.3 PROJECT DEFINITION (10%-15%).

The Preconcept Design Analysis shall include the requirements stated below and shall include all data and any calculations(if required) to support design decisions and estimates at this stage of design. The analysis shall incorporate specific criteria furnished and conference minutes of all systems considered. The analysis shall include the following:

17.3.1 Interior Electrical System Design Analysis Narrative.

(1) Provide brief description of the Electrical Characteristics (phase voltage and number of wires) for electrical system(s). Justification for the type of system proposed (Economical or Special Condition).

(2) Provide brief description of the lighting system(s) to be used for major areas.

(3) State type of wiring system, such as rigid or intermediate conduit, electrical metallic tubing, nonmetallic sheathed cable, etc., that will be use.

(4) Provide a paragraph describing special items of design, such as equipment, handicapped and seismic requirements, etc.; include description and location.

(5) Clearly define and completely indicate any and all hazardous areas with the applicable class, group, division, and suitable operating temperature as defined in the National Electrical Code. Do not attempt to “design around” the hazardous areas in lieu of designating the areas. State source of criteria, such as Safety Officer or some other recognized official. Include documentation of the source of the criteria.

(6) Indicate if a lightning protection system will be required; if none, so state. (Reference TM 5-811-3 and AMCR 385-100)

(7) Provide brief description of the grounding system to be installed. If a counter poise, grid, EMI shielding requirements, etc., is to be utilized, state standards to be used.

(8) List Corps of Engineers' Guide Specifications that will be used. The designer shall obtain the appropriate guide specifications and use them for design guidance.

(9) Provide a firm statement that no brand names or proprietary items will be used in final plans and specifications.

(10) Indicate if electrical metering equipment to be provided. If facility has an UMCS (EMCS) System, address method to provide signals to master station.

(11) Provide a statement that no duct or liquid piping shall pass over electrical equipment in accordance with NEC 384 and as amended elsewhere in this manual. See Exhibit 17-3.

17.3.2 Interior Electronic Systems Design Analysis Narrative.

(1) Where additions or alterations to existing systems are to be made, verify that the systems are expandable and can accommodate the additions or alterations. Provide a description of all proposed additions and alterations to each system.

(2) Provide a descriptive narrative of all electronic systems that are required for project. A list of some of the possible electronic components and/or systems that may be required on a given project are as follows:

(a) Telecommunication/Data Systems

(b) Fire Detection and Alarm System

(c) Fire Suppression System Controls

(d) Cathodic Protection

(e) Special Grounding Systems

(f) Public Address Systems

(g) Security Systems

(3) Define any hazardous areas (as defined in the National Electrical Code) and indicate the type of equipment proposed for use in such areas.

(4) List the specifications that will be used.

17.3.3 <u>Exterior Electrical Distribution System Design Analysis Narrative</u>.

(1) Make a statement, with documentation, that the primary supply is adequate to support the added load. If the primary source is inadequate, state measures proposed to correct the deficiency in the design.

(2) Provide brief description of the electrical characteristics of power supply from the service point to the main service equipment (voltage, phase, number, and size of conductors).

(3) Provide brief description of the conductor type(s), such as copper or aluminum, and the proposed areas of use and a justification for the choice made.

(4) Provide brief description of the standards of design, such as physical characteristics of overhead and/or underground circuits. If underground, state the basis for the selection. Reference applicable conclusions and/or calculations(if necessary). State short circuit current available at project site and state the source of this data.

(5) A statement will be included describing all exterior lighting, with handicapped features if required.
(6) List Specifications that will be used. The designer shall obtain the specifications listed and use them as design criteria.

(7) Include a statement that no brand names or proprietary items will be used in the final plans and specifications.

17.3.4 <u>Exterior Electronic System Design Analysis Narrative</u>.

(1) Provide a statement describing the extent of any exterior work such as telephone lines, duct banks, etc., outside of 5 feet from the building line. Provide brief description of the standards of design.

(2) Provide the name of the licensed Corrosion Engineer or NACE Specialist. Provide the following for cathodic protection systems:

(a) Clearly define areas of structures or components in soil or water to be protected.

(b) Type system recommended, comparison of systems, and cost estimate showing all equipment alternatives.

(3) List the specifications that will be used.

17.4 CONCEPT DESIGN (30%-35%).

The Concept Design Analysis shall include the requirements stated below and shall include all data and calculations to support design decisions and estimates at this stage of design. The analysis shall incorporate specific criteria furnished and conference minutes of all systems considered. The analysis shall include the following:

17.4.1 Interior Electrical System Design Analysis Narrative.

(1) Indicate Electrical Characteristics (phase voltage and number of wires) for electrical system. Justification for the type of system proposed (Economical or Special Condition).

(2) Provide brief description of the lighting system(s) to be used for major areas and referencing calculations. Also include tabulation, showing the following:

a. Room, name, and number.

b. Lighting intensity for each room. (State design basis such as I.E.S., Definitive Drawings, etc.)

c. Type of fixture, either by Standard Drawing Number 40-06-04 or, if not applicable, include three (3) manufacturers' catalog cut sheets of each fixture type.

(3) State type of wiring system, such as rigid or intermediate conduit, electrical metallic tubing, nonmetallic sheathed cable, etc., and location of proposed use.

(4) Provide a paragraph describing special items of design, such as equipment, receptacles, handicapped and seismic requirements, etc.; include description and location. Reference pertinent NEMA or any recognized standards to identify type receptacles selected.

(5) Clearly define and completely indicate any and all hazardous areas

with the applicable class, group, division, and suitable operating temperature as defined in the National Electrical Code. Do not attempt to "design around" the hazardous areas in lieu of designating the areas. State source of criteria, such as Safety Officer or some other recognized official. Include documentation of the source of the criteria.

(6) Describe lightning protection system; if none, so state. (Reference TM 5-811-3 and AMCR 385-100)

(7) Describe grounding system to be installed. If a counter poise, grid, EMI shielding requirements, etc., is to be used, state standards to be used in design calculations.

(8) Describe basic characteristics of panelboards, protective devices, switchgear, motor control centers or other major equipment to be provided. Short circuit and voltage drop calculations must be included to the service. Indicate equipment interrupting rating and short circuit withstand current, and include the source of this information. Evidence shall be included to support that the equipment is manufactured or can be manufactured and supplied by at least three reliable manufacturers and that the space is adequate for the equipment having the greatest dimensions.

(9) List Corps of Engineers' Guide Specifications that will be used. Use Mobile Guide Specifications where available. The designer shall obtain the appropriate guide specifications and use them for design guidance.

(10) Provide a firm statement that no brand names or proprietary items will be used in final plans and specifications.

(11) Describe electrical metering equipment to be provided. If facility has an UMCS (EMCS) System, address method to provide signals to master station.

(12) Provide a statement that no duct or liquid piping shall pass over electrical equipment in accordance with NEC 384 and as amended elsewhere in this manual. See Exhibit 17-3.

17.4.2 Interior Electronic Systems Design Analysis Narrative.

(1) Where additions or alterations to existing systems are to be made, verify that the systems are expandable and can accommodate the additions or alterations. Provide a description of all proposed additions and alterations to each system.

(2) Provide a descriptive narrative of all electronic systems that are required for project. A list of some of the possible electronic components and/or systems that may be required on a given project are as follows:

(a) Telecommunication/Data Systems

(b) Fire Detection and Alarm System

(c) Fire Suppression System Controls

(d) Cathodic Protection

(e) Special Grounding Systems

(f) Public Address Systems

(g) Security Systems

(3) Telephone layout information should be furnished from the Using Service on "marked-up" 30%-35% drawings.

(4) Clearly define and completely indicate any and all hazardous areas with the applicable class, group, division, and suitable operating temperature as defined in the National Electrical Code. Do not attempt to “design around” the hazardous areas in lieu of designating the areas. State source of criteria, such as Safety Officer or some other recognized official. Include documentation of the source of the criteria.

(5) List the specifications that will be used.

17.4.3 Exterior Electrical Distribution System Design Analysis Narrative.

(1) Make a statement, with documentation, that the primary supply is adequate to support the added load. If the primary source is inadequate, state measures proposed to correct the deficiency in the design. Reference photographs of existing substations, pole line structures, or other exterior components. The photographs shall be included in the design analysis of all affected equipment and structures.

(2) Provide electrical characteristics of power supply from the service point to the main service equipment (voltage, phase, number, and size of conductors).

(3) Indicate type, number, kVA capacity and impedance of transformer installation proposed and state method of sizing. State primary and secondary connections of transformers (i.e., 12470 to 480Y/277 volts, Delta-wye) in accordance with ANSI C57.12.00.

(4) State type of conductor, such as copper or aluminum, and where proposed to use and a justification for the choice made.

(5) A statement will be included describing standards of design, such as primary and secondary voltage drop, and physical characteristics of overhead or underground circuits. If underground, state the basis for the selection. Reference applicable conclusions and/or calculations. State short circuit current available at project site and state the source of this data.

(6) A statement will be included describing all exterior lighting, with handicapped features if required. IES point to point calculations shall be submitted to support the selection for the aforementioned lighting system.

(7) List Specifications that will be used. The designer shall obtain the specifications listed and use them as design criteria.

(8) Include a statement that no brand names or proprietary items will be used in the final plans and specifications.

17.4.4 Exterior Electronic System Design Analysis Narrative.

(1) Provide a statement describing the extent of any exterior work such as telephone lines, duct banks, etc., outside of 5 feet from the building line.

(2) Provide the name of the licensed Corrosion Engineer or NACE Specialist. Provide the following for cathodic protection systems:

(a) Clearly define areas of structures or components in soil or water to be protected.

(b) Type system recommended, comparison of systems, and cost estimate showing all equipment alternatives.

(c) Calculations on all systems that are considered, showing all information and descriptions.

(d) Estimate showing materials and cost.

(3) List the specifications that will be used.

17.4.5 Concept Design Drawings (30%-35%).

17.4.5.1 Interior Electrical.

(1) Show typical room lighting and receptacle layouts on floor plan.

(2) Show the service and the main electrical service equipment and size same.

(3) Show the location of all major pieces of electrical equipment, including panelboards.

(4) Show the proposed riser diagram. Sizes of all conduit, wires, cables, panels, etc., need not be included, except for the main service feeder. Where the electrical configuration cannot be adequately explained on a power riser diagram, a complete one-line diagram will be provided.

(5) Provide samples of panelboard, switchboard, motor control and fixture schedules. (See EXHIBIT 17-1 and 17-2.)

(6) Clearly define and completely indicate any and all hazardous areas with the applicable class, group, division, and suitable operating temperature as defined in the National Electrical Code. Do not attempt to “design around” the hazardous areas in lieu of designating the areas. State source of criteria, such as Safety Officer or some other recognized official. Include

documentation of the source of the criteria.

17.4.5.2 Interior Electronic Systems.

(1) Show the location of all electronic system panels, etc., on floor plans.

(2) Show the proposed riser diagrams for all systems. Sizes of conduit, wires, cables, panels, etc., need not be included at the 30%-35% design. (See EXHIBIT 17-5, 17-6, 17-7, 17-8, 17-9)

(3) Provide a complete symbol legend for all devices or equipment shown on the plans.

(4) It may be necessary for the designer to provide a recommended layout for telephone, LAN, and CATV on floor plan.

17.4.5.3 Exterior Electrical.

(1) Existing and new electrical primary lines both overhead and underground shall be properly identified.

(2) Show removals and relocations, if any. If extensive, provide separate drawing(s).

(3) Indicate electrical characteristics of all items shown; include voltage, phase, conductor size, and kVA.

(4) Show new construction and location of transformers.

(5) Indicate the secondary service to the facility and whether it is overhead or underground.

(6) Show guy leads and guy strengths on the plans. Guying calculations shall be submitted verifying the guying design shown.

17.4.5.4 Exterior Electronic Systems.

(1) Exterior work to be shown on electrical site plan or separate Electronic systems site plan.

(a) Existing and new communications service lines, both overhead and underground, shall be properly identified.

(b) Identify any Gas and Water lines that are to be protected by the Cathodic Protection System.

(c) Show removals and relocations, if any.

17.4.6 Concept Removal or Demolition.

A general narrative of the removal and/or demolition will be included.

17.4.7 Concept Additional Criteria/Information.

Any additional criteria, deviations concerning criteria, questions or problems will be listed.

17.5 INTERIM DESIGN (50%-60%).

17.5.1 Interim Design Analysis.

This stage of Design Analysis shall be an entirely updated analysis (not amendments to concept submittal) to permit verification that the design complies with the criteria furnished and the approved Concept Design. Short circuit and voltage drop calculations shall be included to all panelboards.

17.5.1.1 Interior Electrical System Design Analysis Narrative.

(1) Indicate Electrical Characteristics (phase voltage and number of wires for the electrical system. Justification for the type of system proposed (Economical or Special Condition). A life cycle analysis is required on 120/208 volt system above 300 kVA.

(2) Provide description of lighting system(s) to be used for all areas, referencing calculations and economic analysis. Also include tabulation, showing the following:

(a) Room name and number

(b) Lighting intensity for each room. (State design basis such I.E.S., Definitive Drawings, etc.)

(c) Type of fixture, either by Standard Drawing Number 40-06-04 or, if not applicable, provide three (3) manufacturers' catalog cut sheets of each fixture not in the 40-06-04.

(3) State type of wiring system, such as rigid or intermediate conduit, electrical metallic tubing, nonmetallic sheathed cable, etc., and location of proposed use.

(4) Provide a paragraph describing special items of design, such as equipment, receptacles, handicapped and seismic requirements, etc.; include description and location. Reference pertinent NEMA or any recognized standards to identify type receptacles selected.

(5) Clearly define and completely indicate any and all hazardous areas with the applicable class, group, division, and suitable operating temperature as defined in the National Electrical Code. Do not attempt to "design around" the hazardous areas in lieu of designating the areas. State source of criteria, such as Safety Officer or some other recognized official. Include documentation of the source of the criteria. Insure that all devices installed in hazardous classified locations are shown and/or specified as suitable for the location in which they are installed.

(6) Describe lightning protection system; if none, so state. (Reference TM 5-8ll-3 and AMC-R 385-100.)

(7) Describe grounding system to be installed. If a counterpoise, grid, etc., is to be used, state standards to be used in design calculations.

(8) Describe basic characteristics of panelboards, protective devices, switchgear, motor control centers or other major equipment to be provided. Short circuit and voltage drop calculations must be included to <u>all</u> panelboards. Indicate equipment interrupting rating and short circuit withstand current, and include the source of this information. Evidence shall be included to support that the equipment is manufactured and/or can be manufactured and supplied by at least three reliable manufacturers and that the space is adequate for the equipment having the greatest dimensions.

(9) List Corps of Engineers' Guide Specifications that will be used.

(10) Provide a firm statement that no brand names or proprietary items will be used in final plans and specifications.

(11) Describe electrical metering equipment to be provided. If facility has an UMCS (EMCS) System, address method to provide signals to master station. (See paragraphs 17.8.1.1 and 17.8.1.2.)

(12) Provide a statement that no duct or liquid piping shall pass over electrical equipment in accordance with N.E.C. 384 and as amended by this manual. (See EXHIBIT 17-3.)

(13) Include a statement certifying that the designer has implemented the 30%-35% annotated comments.

17.5.1.2 <u>Exterior Electrical Distribution System Design Analysis Narrative</u>.

(1) Make a statement, with documentation, that the primary supply is adequate to support the added load. If the primary source is inadequate, state measures proposed to correct the deficiency in the design. <u>Reference photographs of existing substations, pole line structures, or other exterior components. The photographs shall be included in the design analysis of all affected equipment and structures.</u> Properly label all photographs indicating pole location, pole designation and view orientation of picture.

(2) Provide electrical characteristics of power supply from the service point to the main service equipment (voltage, phase, number, and size of conductors).

(3) Indicate type, number, kVA capacity and impedance of transformer installation proposed. State primary and secondary connections of transformers (i.e., 12470 to 480Y/277 volts, Delta-wye), in accordance with ANSI C57.12.00.

(4) State type of conductor, such as copper or aluminum, and location of proposed use and a justification for the choice made.

(5) A statement will be included describing standards of design, such as primary and secondary voltage drop, and physical characteristics of overhead or underground circuits. If underground, state the basis for the selection. Reference applicable conclusions and/or calculations. State short circuit current available at project site and state the source of this data.

(6) A statement will be included describing all exterior lighting, with handicapped features if required. Types of fixtures, pole heights, and proposed intensities are to be included. IES point to point calculations shall be submitted to support the selection for the aforementioned lighting system.

(7) List Guide Specifications that will be used.

(8) Include a statement that no brand names or proprietary items will be used in the final plans and specifications.

17.5.2 Interim Design Drawings (50%-60%).

17.5.2.1 General.

(1) All removals must be shown. If removals are extensive, separate demolition plans are required. The designer shall display the information in such a manner that it would not be necessary to visit the site to prepare a bid.

(2) A complete legend shall be provided for all devices and equipment shown on the plans. Mounting heights shall be included as applicable.

17.5.2.2 Interior Electrical.

(1) Power riser or one-line diagram shall be essentially complete except for finalization of conduit and wire sizes.

(2) Panelboards, motor control centers, switchgear equipment and all utilization equipment shall be located with schedules and physical layout arrangement completed. Provide front elevations for free-standing equipment.

(3) Branch circuits, lighting fixtures with switches, receptacles, and motors shall be shown with number of conductors indicated.

(4) A completed fixture schedule shall be included on the drawings.

(5) Before submittal, drawings shall be thoroughly checked by the designer for discrepancies and conflicts, particularly as related between disciplines and various systems above dropped ceiling.

17.5.2.3 Electronic Systems.

(1) All exterior plans should be completed.

(2) Thoroughly check for discrepancies and conflicts, particularly between disciplines.

(3) Any removals required must be shown. If removals are extensive, demolition plans are required.

(4) Cathodic protection system should be complete, including analysis, narrative description of system, and drawings. The submittal shall include drawings showing all structures or components to be protected and all cathodic protection components in relation to the protected structure. This includes showing sacrificial and impressed current anodes, rectifiers, isolation (dielectric) bonding and any other data needed to define the scope and area of the cathodic protection system.

(5) Provide riser diagrams for fire detection and alarm system, intrusion detection system, public address system, telephone system, etc. Risers should show the location of the various components and interconnections with other systems such as HVAC panel connections to fire alarm panels, etc. (See EXHIBIT 17-5, 17-6, 17-7, 17-8, 17-9)

(6) Show location of all devices and equipment for electronic systems on the floor plans. Show location of devices to be interconnected; e.g., show duct-mounted smoke detectors, hood fire-suppression system contacts for fire alarm system input, etc. Location of all devices shall conform to NFPA 72 and MIL HDBK 1008C and ADA.

(7) Provide details of telephone outlets, telephone backboard arrangement, and other items required by criteria or comment.

(8) Provide data for special ground system.

17.5.2.4 Exterior Electrical.

All exterior electrical shall be completed in plan with poles and other pertinent components detailed. Details shall include transformer's location, type of construction, kVA, impedance, voltage, phase, and type, size and number of conductors. If manholes or handholes are required for underground, utilize typical manhole from TM 5-811-1. Manholes and/or handholes shall be detailed on final drawings.

17.5.3 Additional Criteria.

Any additional criteria, deviations concerning criteria, questions or problems should be listed.

17.6 FINAL DESIGN (Unreviewed 100%).

17.6.1 Final Design Analysis.

This analysis is an extension of the approved 50%-60% design analysis and supports and verifies that the design complies with the requirements of the project.

A coordination analysis of the electrical system shall be provided on all projects to properly indicate that all of the protective devices are fully coordinated. If required by paragraph 17.6.3(6), the designer shall provide a complete coordination study including the identity of the manufacturer and equipment used in preparing the curves. The study shall include all panels.

17.6.2 <u>Final Design Drawings</u>.

The final drawings are an extension of the approved 50%-60% drawings and shall incorporate the 50%-60% comments.

(1) All details for final package shall be on the drawings (pole details, fixture details, etc.). Congested areas where there can be interference with various electrical systems, cable trays, piping, ducts, etc., shall be thoroughly detailed by expanded scale drawings.

(2) Thoroughly check the drawings for discrepancies, for compatibility between drawings and specifications, and for compatibility between disciplines. Check the following, as a minimum, but <u>DO NOT LIMIT CHECKING TO THESE ITEMS</u>:

(a) Verify compatibility between electrical, electronic systems, and other disciplines (equipment locations, reflected ceiling plans, motor voltage and across the line as reduced voltage starters and horsepowers, NEMA enclosures, plans and specifications for systems furnished in other specification sections, etc.), to ascertain that there are no conflicts on the drawings.

(b) Panelboards, motor control centers, switchboard and switchgear schedules, home runs, and floor plans.

(c) Power riser or one-line diagram configuration agrees with floor plans.

(d) Legend and/or symbols complete and compatible with drawings.

(e) Fixture types indicated on the drawings agree with fixture schedule.

(f) Assure design complies with design analysis and criteria.

(g) Adequacy of details and control diagrams.

(h) Proper and practical circuitry with number of conductors and conduit sizes indicated correctly.

(i) Clearly define and completely indicate any and all hazardous areas with the applicable class, group, division, and suitable operating temperature as defined in the National Electrical Code. Do not attempt to “design around” the hazardous areas in lieu of designating the areas. State source of criteria, such as Safety Officer or some other recognized official. Include documentation of the source of the criteria. Insure that all devices installed in hazardous classified locations are shown and/or specified as suitable for the location in which they are installed.

(j) Ensure that all Electronic Systems are provided with power.

(k) Ensure that the proper receptacle types(s) are provided for the specific special purpose equipment that will be used in the facility. Obtain equipment list and requirements from user.

17.6.3 Specifications.

(1) Read thoroughly and comply with the instructions in front of each set of guide specifications, including notes to specification writer. The SPECINTACT specification writing system shall be used for specification preparation.

(2) Cross out nonapplicable index items, publications, paragraphs, phrases, words, and sentences. Fill in blanks as applicable.

(3) Add publication references, paragraphs, phrases, words, and sentences for items not adequately covered by specifications.

(4) Do not specify proprietary items.

(5) Ascertain that major or special types of equipment are available commercially.

(6) For a design whose demand load is 500 kVA and above, or is for a processing system that would be undesirable for the system to cease functioning, the specifications shall require the contractor to provide a system short circuit study and coordination curves for the equipment to be furnished. The study and curves shall be approved prior to approval of shop drawings for the equipment.

(7) If the design is predominately exterior overhead or underground with a small amount of information required that is contained in the interior electrical specification, the design specifications may include excerpts from the interior specifications in either the overhead or underground specifications and the title changes to "Electrical". This procedure must have prior approval.

17.7 READY-TO-ADVERTISE (100%).

The comments generated during the Final Review shall be incorporated into the completed design analysis (not amended sheets), specifications, and drawings before they are submitted as Ready-to-Advertise.

The analysis shall be complete and shall support the requirements of the project.

The drawings and specifications shall be complete and thoroughly checked. Where additions to existing electronic systems are made, the designer shall have verified that the existing system is expandable and can accommodate the additions. This verification shall include an on-site survey of the system and contacts with the manufacturer to ensure that the expansion modules, etc., are available. Information on manufacturer, model number, etc., of the existing electronic equipment shall be included in the plans and specifications. This is typical of expansions made to fire alarm and public address systems.

17.8 TECHNICAL REQUIREMENTS.

17.8.1 Metering.

17.8.1.1 Air Force Projects.

(1) New Facilities.

(a) Each energy consumption meter installation cost must not exceed 15% of the estimated annual utility bill for the fuel or energy consumption to be measured.

(b) Energy consumption meters will not be installed on facilities with an annual energy consumption of less than $6,000, unless usage is proven cost effective.

(2) Renovated Facilities.

(a) The cost of the total number of meters will not exceed one percent of the project programmed amount.

(b) Each energy consumption meter installation cost must not exceed 15% of the estimated annual utility bill for the fuel or energy consumption to be measured.

(3) Calculations shall be included to ensure that the meters are/are not required.

(4) Meters selected will be American National Standards Institute (ANSI), C12, and C12, 10, except numbered terminal wiring sequence and case size may be the manufacturer's standard. Watthour meters shall be of the drawout switchboard type having a 15-minute cumulative form, demand register meeting ANSI C12.4 and provided with not less than two and one-half stators. Watthour demand meters shall have factory-installed electronic pulse initiators meeting the requirements of National Electrical Manufacturers Association (NEMA) F1 13. Pulse initiators shall be solid-state devices incorporating light-omitting diodes, photo-transistors, and power transistors, except that mercury-wetted output contacts are enclosures, shall be capable of operating up to speeds of 500 pulse per minute with no false pulse, and shall require no field adjustments. Initiators shall provide the maximum number of pulses per kWh up to 500 per minute with a 5-amp input that is obtainable from the manufacturer. It shall not provide less than one pulse per kWh.

17.8.1.2 Army Projects.

Installation of permanent utility meters for both new construction and alteration, rehabilitation, and modernization projects shall be as follows:

(1) Electrical meters of the kilowatt-hours and 15-minute kilowatt demand type with a kWh pulsing device will be provided on the items listed below:

(a) Each man post and large area substation or switching station and each circuit leaving such station.

(b) Feeders serving major areas, such as barrack complexes.

(c) Typical large or unique structures on each installation, such as field houses, commissaries, medical facilities, administrative buildings, barracks, dining facilities, and major nonappropriated funded facilities.

(2) Electrical meters of the kilowatt demand type will be provided on distribution substations having capacities of 500 kVA or larger which serve more than one structure. Permanent utility meters will be installed with provisions to isolate and remove meters for calibration and maintenance and will be suitable for operation in conjunction with an energy monitoring and control system.

17.8.2 Salvageable Material.

The salvageable material resulting from a demolition design and not reincorporated in the design remains property of the U.S. Government. The debris will be disposed of as directed by the Contracting Officer. Typical removal paragraphs are listed below.

17.8.2.1 Removals.

Where indicated, existing equipment and material shall be removed and shall remain the property of the Government. Salvageable equipment and materials shall be delivered to the Contracting Officer for storage on the premises as directed. Materials and debris considered unsalvageable by the Contracting Officer shall be disposed of as directed.

17.8.2.2 Reuse of Removed Materials.

Removed materials with the exception of poles shall be reused if they are in good condition and they meet the requirements of this section of the specifications. Removed wood poles shall not be reinstalled. (Removed materials not incorporated in the new work shall be delivered to storage and disposed of as directed by the Contracting Officer.)

17.8.3 Special Items.

The following items will be included in each submittal, where applicable:

(1) Corps of Engineers guide specs must be used in preparing contract specifications for diesel-electric generators. Unless application requires otherwise, provide brushless type generators.

(2) Egress lighting must comply with life safety code NFPA 101. In the concept and design analysis, write up reference paragraph and chapter that the design is based upon.

(3) Facilities requiring design for the handicapped shall comply with the Uniform Federal Accessibility Standards as outlined in 41-CFR-101-19.6, as well as the American with Disability Act (ADA), and all state and local laws and standards for buildings and facilities requiring accessibility and usability for physically handicapped people. These instructions cover such items as switch heights, adequate lighting at ramps, exit lights, etc. The most stringent of these codes shall be applicable.

(4) In areas where the probability of hurricanes are high, distribution systems and equipment outside of buildings are to be adequately anchored, braced, or guyed to withstand hurricane winds. Details with supporting design analysis and specifications will be provided to verify conformance with the applicable codes and regulations for the specific project location.

(5) Provide both green grounding conductors and driven electrodes for exterior lighting poles.

(6) Seismic design, when required, shall be in accordance with TM 5-809-10.

(7) Dedicated electrical space shall be provided around and above panelboards, switchboards, transformers, transfer switches, motor control centers and similar major items of electrical equipment. This space shall be defined as follows:

(a) The space in front of the equipment shall be defined in Table 110-16(a) of the NEC (3 feet minimum). The space to the sides of the equipment shall be 15 inches. This area of space shall be extended to the ceiling to define a volume of dedicated space through which no pipes, ducts, or equipment foreign to the electrical equipment shall be permitted to be installed in, enter, or pass through.

(b) The ceiling is defined as the structure above. A false ceiling is not to be considered adequate.

(c) This dedicated space shall be designated on the drawings as dedicated space by note or by symbol.

(d) Exhibit l7-3 defines this space.

(8) Fire Resistant Ceilings. When the false ceiling is used as the fire resistant ceiling, then the lighting fixtures shall be installed in accordance with Underwriters Laboratories Fire Resistance Directory. The lighting fixtures specified shall be classified for fire resistance and will

be so noted in the lighting fixture schedule.

(9) All air-cooled chillers shall be served by a fused disconnect switch. The fuse size shall be as indicated by the name plate on the equipment installed.

(10) Electrically-driven fire pumps. The designer will insure that the requirements of NFPA 20 are met in all designs that include fire pumps. In particular, a letter from the installation servicing maintenance engineer agency confirming reliability of the utility service (Para. 6-2.1, NFPA) and calculations that substantiate the starting voltage drop requirements (Para. 6-3.1.3 and 6-3.1.4, NFPA) must be submitted by the designer.

(11) Interior Lighting Systems. Interior lighting accounts for a significant portion of electrical energy consumed in a building. Energy is saved and electric demand reduced by improving lighting system efficiency and using daylighting. The lighting design shall incorporate the latest techniques of energy savings applied to lighting systems. Lighting designs shall incorporate high efficiency fluorescent tubes. Designs for work within existing buildings shall be compatible with the existing system. When designing new lighting systems the designer shall consider incorporating the following features into the lighting design: high efficiency electronic ballasts, the use of automated dimmers sensitive to the amount of natural light in the space, the use of motion detectors and/or other devices to automatically turn off lights in unoccupied rooms.

(12) Nonmetallic sheathed cable will be included in all Army designs, and in Air Force where allowed by MIL HDBK 1190, as allowed by the National Electric Code. In CMU block construction, a detail will be included to indicate how the cable shall traverse through the block and bond beams.

(13) Obtain instructions from MDO pertaining to Arms Rooms. Refer to EXHIBIT l-5.

(14) Electrical Service to Army Reserve Centers shall be underground as required in the "Design Guide" furnished to all designer's designing ARC's. The primary will be extended UG from the property line to a padmounted transformer near the mechanical room, and then an UG secondary will be extended into the building. A letter must be furnished (as part of the 30%-35% design analysis) from the power company giving the costs and all their requirements for the complete installation of the UG service. Where an exact cost cannot be furnished, an estimate will be adequate for the 30%-35%. An exact cost, however, must be obtained before the Final (unreviewed 100%) submittal for inclusion in the specifications as a separate bid item.

(15) The thickness of long runs of “grounding” bus bar shall be 3” X ½” if shown to be supported at 5 ft. intervals. If thinner bus bar (1/4”) is used, supportive intervals shall be at 2-ft.

(16) Provide service entrance equipment with a single main breaker for all facilities at Homestead AFS.

(17) Insure that the Impedance for the main transformer(s) are shown on

the drawings and/or covered in the specifications.

(18) Low-pressure sodium light fixtures shall be utilized for installations where use of other types of HID fixtures present environment concerns (e.g. impact on marine life such as sea turtles). See also, installation site specific criteria.

(19) Where applicable, provide lighting controls on stage in classrooms and assembly rooms where instructions take place.

17.8.4 Design Criteria for Nonlinear Loads.

The design of the electrical distribution (both normal and emergency power) shall consider the effects that harmonics from non-linear loads can produce on the system. Harmonics from non-linear loads can affect the sizes of the neutral conductor, panelboards, phase conductors and emergency generators. Design for facilities having nonlinear loads shall be in accordance with ETL 1110-3-403 dated June 1989. Per the requirements of paragraphs 4c and 4g, the use of 75 degree C. (minimum) conductors is required and must be shown as such on the drawings. Eight-wire branch circuits within the building which serve nonlinear loads shall be 3#12, 3#10 N., 1#12 GND., and 1#12 Isolated GND. Feeders serving panelboards with nonlinear loads shall have the neutral conductor ampacity based on at least 1.73 the ampacity of the phase conductors. The simplest way to accomplish this is a double ampacity neutral or parallel neutrals in sizes allowed by the National Electrical Code.

"K" rated transformers shall be used where the associated panelboards are feeding a large quantity of non-linear loads. Special attention shall be given to the harmonics produced by variable speed and variable frequency drive units for control of HVAC equipment.

17.8.4.1 The following sentence shall be included in paragraph 7.7.2 of SECTION 16415 (ELECTRICAL WORK, INTERIOR):

(1) "Conductor sizes for nonlinear loads (as shown on the drawings) are based on the use of 75 degree C. (minimum) insulated conductors for the branch circuits and feeders."

17.8.5 Telecommunication/Data Systems.

Telephone service entrance cables will be provided by the telephone company to the site. The designer shall design a raceway system from a point on site designated by the telephone company or using agency into the main telephone room in the facility. All conduit shall be concrete encased when run underground. Spare conduit(s) shall be included in the service entrance run. While the telephone service may be provided by the Telephone Company, the designer shall verify all telephone/data requirements.

17.8.5.1 General Design.

Design shall include the provision of required electrical components and a complete raceway system and cabling for the telecommunications system. Sufficient details for cabling, conduits, raceways, wiring ducts, and similar delivery means for telecommunications services shall be provided to guide the Contractor in their installation. The incoming telephone service raceways and primary communications room shall be kept separate from the electrical service raceways and main electrical equipment room. These services must remain separate through to the final point of delivery in user areas.

17.8.5.2 Additional Design Guidance.

The following additional design guidance must be practiced:

(1) The designer shall incorporate into the design a telephone system in accordance with all pertinent regulations and guidelines and with criteria provided. This may include a complete and operational telephone system or prewire the building such that the telephone equipment may be installed by others. The designer must specify all cable, modular outlets, etc.

(2) Telephone outlet locations should be provided to the designer by the Using Agency. Coordinate with the Project Manager for requirements. Show location of telephone outlets on the plans. Include notation or symbol definition to indicate height above finished floor (A.F.F.).

(3) Show Telephone Conduit System Riser Diagram on the plans. Size conduit on Riser Diagram. Do not show conduit runs between the telephone closet backboards and outlets on the floor plans.

(4) Underground telephone entrance conduit shall be shown on the electrical site plan or separate electronic systems site plan. If installation to an existing pole, manhole, etc., is not required and if an entrance conduit termination location is not designated by the local telephone company as indicated above, the conduits must extend 5 feet, as a minimum, outside building and should be clear of any decorative wall, sidewalks, parking areas, etc., with a clear, planned route to the service connection point (pole, manhole, etc.). Outside of the building, the conduit should be capped and the location marked for future installation of cable by telephone company. All underground conduits should be a minimum of thirty (30) inches below grade and concrete encased.

(5) When involved with a large complex or building (i.e., multibuilding complex, etc.), make a determination as early as possible if a private automatic branch exchange (PABX) is or will be planned. PABX installations require special considerations (e.g., space, additional HVAC, vented exhaust systems for batteries, rated walls, hazardous area, etc.). Often, the plans for a PABX may not be stated in the specific project document. State any requirement or anticipated plans for a PABX in the concept design analysis along with all data justifying this need.

(6) When telephone outlets are installed in prewired work stations, the cable shall be a continuous run from the outlet to the connector block at the backboard.

(7) The designer shall insure that the telephone system design complies with the Uniform Federal Accessibility Standards as well as the American with Disability Act (ADA), and all state and local laws and standards for buildings

and facilities requiring accessibility and usability for physically handicapped people. These instructions cover such items as the height of payphones, These requirements may require that power outlets be provided next to telephones for TDD devices.

(8) Provide show telephone jack in each Elevator Equipment Room. Add a note on title drawing statin g that “The Contractor shall obtain the elevator response telephone number from the base via the Contracting Officer.”

(9) Check with the base Communications Officer for requirements associated with providing a LAN (Local Area Network) connections to the mechanical HVAC DDC Controls. Coordinate with the Mechanical designer.

(10) Include provisions for under floor routing of microphone and other types or cables in courtrooms and similar areas.

17.8.6 <u>Fire Detection and Alarm System</u>.

The fire detection and alarm system shall comply with the following design guidance where applicable.

(1) System shall conform to the NFPA Codes and ADA Requirements.

(2) Do not show wire or conduit size, or the quantity of conductors in the circuits, as they will vary with different manufacturers and shall be required by the specifications to be included in the shop drawings. One exception to this requirement is the AC power circuit to the fire alarm equipment.

(3) Show location of all system components on the floor plans. Use NFPA 170 standard symbols.

(4) Provide a riser diagram showing the control panel, annunciator panel (if required), all zones, radio transmitter (if required) and interfaces to other systems (HVAC, sprinkler, hood dry chemical, etc.).

(5) Primary power shall be provided from a lockable breaker in electrical panel nearest to the electrical service entrance. Backup power shall be provided by batteries and charger.

(6) The fire alarm system must report to a Central Station. if required, (which will send an alarm signal to the local fire station) via transceiver, transmitter connected to telephone lines or existing fire reporting system. Conduit and wire in building to be included in design. The Contractor does not normally supply the central station receiver module; however, any equipment supplied must be fully compatible with the central station equipment. The make and model number of control station equipment must be determined for inclusion in the specifications.

(7) The specific project Criteria shall be followed for specific requirements. All ambiguities or conflicts should be clarified early in the design.

17.8.7 Fire Suppression (FS) System Controls.

The controls for fire suppression systems shall be designed in accordance with the following guidance:

(1) Specify all components of the FS System in the FS section of the specifications.

(2) Provide a clear description of how the system will operate and interact with other systems such as the fire alarm system. Be very explicit and detailed in this description.

(3) Include a riser diagram on the drawings showing principal components and interconnections with other systems.

(4) Include FS system components on drawing legend.

(5) Ensure that all components shown on floor plans are designated as FS system components (as opposed to Fire Alarm components).

(6) Show the location of FS control panels, HVAC control devices, sensors, and 120V power panel connections on the floor plans. Do not show the numbers or sizes of conductors or the conduit sizes for detector circuits since this could vary from one supplier to another.

(7) Indicate zoning of areas by numbers (1, 2, 3) and detectors subzoned for cross-zoning by letter designations (A and B). Differentiate between ceiling-mounted and underfloor detectors with distinct symbols and indicate subzone of each.

(8) Coordinate location of detectors with electrical and mechanical drawings to ensure that all detectors are at least 5 feet from air supply ducts and to ensure that no other equipment conflicts with the chosen locations.

(9) Primary power supply will be from a key-locking circuit breaker located in the electrical panel nearest the service entrance. Rechargeable batteries will be used to provide the necessary backup power for system reliability.

(10) Wiring and conduit from the FS control panel to detectors, switches, air-handling shutdown contacts, and FS alarm devices shall be the responsibility of the FS contractor. Wiring and conduit from the FS control panel to the fire alarm panels shall be by the fire alarm contractor, and 120V power source wiring and conduit shall be provided by the electrical contractor.

(11) To assure coordination between contractors and provide a complete workable fire protection system, each section of the specifications must clearly define the responsibilities of the various interrelated system contractors, such as HVAC, Sprinkler, Fire Alarm and Interior Electrical Work.

(12) System shall be designed in accordance with the applicable NFPA

Standards' requirements.

17.8.8 Cathodic Protection.

17.8.8.1 Corrosion Control and Cathodic Protection.

For all metal facilities located in the atmosphere, soil, or water electrolytes, corrosion control shall be provided. In all instances, cathodic protection, or approval to omit it, shall be provided for metals in soils or water. Coatings are normally provided as corrosion protection in the atmosphere. Some of the facilities requiring cathodic protection are as follow:

Water tanks, interior

Underground metal tanks, piping, and ancillary items

Underground metal lift stations

Underground metal pipes - gas and fire suppression

Treatment plants (components in contact with soil or liquids)

17.8.8.2 Qualifications.

Field work, analysis, and design must be accomplished by or under direct supervision of an engineer licensed in corrosion engineering or a technologist, or specialist certified by NACE. As a minimum, he must have 3 years experience in similar installations. He must be available to answer questions relating to his work.

17.8.8.3 Description of Analysis Work.

(1) The geotechnical engineer will conduct measurements in a number of areas to provide the designer data necessary to determine Interim size and type cathodic protection for structures protection. The data is provided in the Foundation Report. The designer is required to obtain resistivity data required.

(2) The designer will conduct current requirement test as required.

(3) The designer must clearly define areas that will be protected and the area that could be affected by interference, and steps to be taken to ensure other structures (pipes, tanks, etc.) are protected from interference.

(4) Provide sufficient and properly-located electrical bonds, electrical insulating devices and corrosion control test stations to ensure adequate allowance for periodic review and examination of the system.

17.8.8.4 Design of Cathodic Protection.

(1) This design shall clearly provide a thorough and comprehensive specification and drawing. The design must meet the requirements of NACE RP0169, NACE RP0188, NACE RP0285, and NACE RP0286. The expected results shall

be provided by field test (in the construction phase) witnessed by the Contracting Officer.

(2) The design must include applicable drawings, as available, showing existing construction. Verification of the validity of these drawings and/or any other data furnished by the Government shall be the responsibility of the engineering services firm.

(3) The designer shall provide an updated cost estimate of the cathodic protection system. This will include all construction and testing costs related to installation of cathodic protection. The estimate shall be a detailed estimate showing equipment, labor, excavation, etc.

(4) The design plans and specifications will show extent of the facilities to be protected, location and type of anodes, location of test points, and details for sectionalizing an underground piping system. This design shall be complete enough to purchase equipment and build without design changes to meet criteria of protection.

17.8.8.5 Criteria of Protection.

Criteria for determining the adequacy of protection on a buried structure are defined in the National Association of Corrosion Engineers Publication RP-01-69. The cathodic protection system shall meet the following minimum criteria for steel and cast-iron structures.

(1) A negative voltage of at least 0.85 volt as measured between the structure and a saturated copper-copper-sulfate reference electrode contacting the electrolyte. Determination of this voltage is to be made with the protective current applied.

(2) A minimum negative voltage shift of 300 millivolts produced by the application of protective current. The voltage shift is measured between the structure surface and stable reference electrode contacting the electrolyte. This criteria of voltage shift does not apply to structures in contact with dissimilar metals.

(3) A minimum negative polarization voltage shift of 100 millivolts measured between the structure and a saturated copper-copper-sulfate reference cell contacting the electrolyte. This polarization voltage shift shall be determined by interrupting the protective current and measuring the polarization decay. When the protective current is interrupted, an immediate voltage shift will occur. The voltage reading, after the immediate shift, shall be used as the base reading from which to measure polarization decay.

17.8.9 Special Grounding Systems.

17.8.9.1 General.

Special grounding systems, such as for computer and electronic equipment; for lightning protection of sensitive electronics equipment, such as radios and communication equipment shall be designed in accordance with the specific project POR document. A common grounding system can be utilized, when practical, for all grounding needs. When separate grounding systems are provided, all grounding systems shall be tied together below grade, unless otherwise directed.

The surface area and lateral extent of the ground electrode in the earth, and resistivity of the earth are major factors in determining the effective resistance of the combination, known as the electrode ground-resistance. Frequently, a single electrode of even the maximum practical dimensions will not provide acceptable electrode ground resistance. In such cases, additional electrodes must be added, all connected together.

17.8.9.2 Qualifications.

For certain special grounding systems, a design specialist will be required by the designer contract. When so indicated, field work, analysis and design must be accomplished by or under the direct supervision of an Engineer having at least 10 years experience in the design of special-type grounding systems and shall have successfully completed at least 10 projects of similar nature. Proof demonstrating the above shall be provided the Contracting Officer. The expert may be a consultant hired especially for the particular project or may be a regular employee of the designer, but his credentials must be acceptable in the judgment of the Contracting Officer.

17.8.9.3 Description of Analysis Work.

(1) The designer will conduct measurements in a number of areas to determine the location, number and length of ground rods to provide the required ground resistance.

(2) The designer shall clearly define areas that could create corrosion problems and necessitate the need for cathodic protection, due to installation of the grounding system.

17.8.9.4 Design of a Ground System.

(1) The specifications and drawings shall completely reflect all of the design requirements. The specifications shall require field tests (in the construction phase), witnessed by the Contracting Officer, to determine the effectiveness of the grounding system.

(2) The design must include drawings showing existing construction. Verification of the validity of any existing drawings and/or any other data furnished by the Government shall be the responsibility of the engineering services firm.

(3) The designer shall provide a cost estimate for the grounding system. This will include all construction and testing cost reflected to installation of the grounding system. The estimate shall be a detailed estimate, showing equipment, labor, excavation, etc.

(4) Use IEEE 142 for additional design guidance.

17.8.10 Public Address Systems.

Public address systems encompass many applications of amplified voice and music used for entertainment and distribution of voice messages. They run the gamut from a speech reinforcement system in a conference room, to a frequency equalized voice and music system for an auditorium, and on to a complex multi-zone system used for both background music and selective paging by zone with multi-media selectable inputs and area level control with paging capability. Most systems involve amplifiers, loudspeakers, and a program input. Inputs include microphones, AM/FM tuners, tape decks, phonographs, and compact disk players. Many configurations can be developed using standard equipment to fit any desired operational requirement. Each system is to be designed to meet the user's criteria requirements.

In many cases, space limitations dictate the use of wall-mounted amplifiers. Dual voice coil speakers should be used for background music systems that require voice paging to override the music levels. The use of miniature relays at zone volume controls to override volume control settings for paging should be avoided. In small systems employing relatively-short runs of audio bus cable and low power requirements, a 25-volt distribution system should be used. Where long runs with high power requirements are levied on the distribution network, a 70-volt system should be used. The choice of all system components should be based on design calculations. These calculations should begin with the desired sound pressure level to be achieved in each area and be developed through the system to establish component power capacity and wire sizes.

Specifications shall include sufficient technical data to establish minimum equipment quality levels. This data shall include frequency response, distortion, RMS power capacity, and minimum number and types of controls. Public address systems shall be designed in accordance with the specifications and EIA standards for sound systems.

All-channel paging, consisting of paging microphone, push-to-talk switch paging amplifier, and one or more paging relays, shall be provided. All accessories, material and other equipment for a complete public address system shall be furnished. The system shall be accessed via the telephone system and may be located in the main telephone equipment room for convenience of interfacing. The design of Public Address System must be coordinated with the telephone system and the user. The system must be sized to be audible at all points throughout the facility. The system can be accessed through individual telephone handsets as well as through PBX switch. The system shall provide hands free talk back capabilities in lab areas.

At a minimum, separate paging zones shall be provided for the following areas: Administrative offices, Chemical labs, Biological labs, General office areas, Hazardous storage areas, Parking lots, and Exterior secured areas. In multi-floor facilities, further zoning will be required. Controls for individual speaker units shall be wall mounted and include volume control and on/off switching.

The system shall comply with the Uniform Federal Accessibility Standards as well as the American with Disability Act (ADA), and all state and local laws and standards for buildings and facilities requiring accessibility and usability for physically handicapped people. These instructions may require additional amplification devices.

17.8.11 Intrusion Detection Systems.

(1) The designer shall design a complete intrusion detection system, as required by user comments and criteria. The designer shall have a minimum of 3 years experience in similar installations. The intrusion detection system shall protect all grade level doors, operable windows and openings leading into the facility as well as roof hatches and roof access doors. Operable windows shall be lockable and accessible windows shall be alarmed. Roof access doors or hatches shall be secured with heavy duty hardware and alarmed. In addition to perimeter protection, alarm a minimum of the interior doors as designated by the user. Door switches shall be of the balanced magnetic type.

(2) A riser diagram of the system shall be included in the drawings.

(3) A lockable circuit breaker shall be reserved for the Intrusion Detection System primary power connection in the 120V power panel located nearest the service entrance.

(4) All signal conductors outside component enclosures must be enclosed in rigid, heavy wall conduit or intermediate metal conduit (IMC). Power cable from the Control Unit and the Monitor Cabinet to their respective junction boxes may be in electrical metal tubing (EMT).

17.8.12 Leak Detection for Underground Storage Tanks.

17.8.12.1 General.

Leak detection must be provided for underground storage tanks and piping which will contain petroleum products or the hazardous materials as required by local, state, or federal regulation. The leak detection provisions shall comply with all requirements established by EPA, State or local regulatory authorization.

17.8.12.2 Guidance.

Specifications for the leak detection system shall be included in the specification section containing the tank and piping. Locations of control panels, cables, conduits, alarms, and all other electrical details associated with the leak detection system shall be shown on the Electrical drawings.

17.8.13 Lightning Protection System.

17.8.13.1 Minimum Scope.

A lightning protection system shall be provided for all facilities containing laboratory modules, as well as for facilities containing radioactive or explosive materials.

17.8.13.2 Additional Scope.

For building types not in the above description, a risk assessment shall be performed using the guides in TM 5-8ll-3 and NFPA 780 to determine the risk of loss due to lightning.

17.8.13.3 Master Label.

For buildings described in paragraph 17.8.19.1 and for facilities with a strong risk potential, furnish and install equipment, accessories, and material necessary for a complete "Master" labeled lightning protection system to protect all building components. The system shall comply with all the requirements of TM 5-8ll-3 and AMC-R 385-100, as well as the National Fire Protection Association (NFPA 780), the Underwriter's Laboratories, Inc., (UL 96A), and the Lightning Protection Institute (LPI 175). All cables, air terminals, and accessories shall be copper. All connections and splices shall be exothermic weld type.

17.8.13.4 Minimum Requirements.

Completed installation shall present an unobtrusive appearance, with conductors built into the building during construction to conceal all conductors, and it shall be properly flashed and watertight. Installation shall be made in conformance with shop drawings prepared by supplier and approved by the Government.

17.8.13.5 Certification Delivery.

Before the lightning protection system is accepted, the contractor shall obtain and deliver to the supervising architect, the "Master Label" of the Underwriters Laboratories, Inc., or an equivalent certification.

17.8.14 Local Area Networks (LAN).

Local Area Networks shall be included for all projects, as required. The basic criteria will be obtained by the user and provided to the designer for inclusion in the project. All LAN outlets installed in prewired work stations shall be wired continuous from the outlet to the backboard, multitap, etc., depending on type system installed.

17.8.15 Radio Frequency Shielding.

17.8.15.1 General.

RF shielding may be required in project criteria for a variety of reasons, including TEMPEST, to protect sensitive electronic equipment from unwanted electrical noise, and to protect certain critical electrical/electronic equipment from the electro-magnetic pulse (EMP) from nuclear explosions. The application and the criteria for the specific project will determine the type of shielding required. The design of anechoic chambers may also be required and should follow the same guidelines outlined herein.

17.8.15.2 Qualifications.

The design of RF shielding is very specialized. The designer shall, therefore, employ the services of an expert in the area of RF shielding and/or anechoic design. The expert must have at least 10 years of experience in the design and construction of RF-shielded facilities and shall have successfully completed at least 10 projects of a similar nature. Proof demonstrating the above shall be provided the Contracting Officer. The expert may be a consultant hired especially for the particular project or may be a regular employee of the designer, but his credentials must be acceptable in the judgement of the Contracting Officer.

17.8.15.3 Design Guidance.

If not contained in the Project Data Book, the designer will be provided the frequency and attenuation requirements at the predesign conference or he will be given other specific guidance detailing the scope of his work. Some design criteria may be contained in classified documents, but usually the pertinent information can be extracted and given to the designer without the designer requiring access to the documents. If access is required, the designer will be so informed prior to the beginning of the contract.

(a) All walls, floors and ceiling in the shielded areas must be shielded.

(b) All shielded areas shall be clearly shown on plans, elevations, sections, details, etc., as necessary to convey the location and extent of the shielding.

(c) The consultant shall select the type of shielding materials to be used, taking into consideration the shielding criteria, the ease of construction, the architectural and functional features of the facility, and the cost. For facilities having shielding requirements greater than 50 dB, copper or steel foil shall not be used as shielding material. In no circumstance shall aluminum foil be used.

(d) The consultant shall coordinate all disciplines having work in the area of the shielding, at the earliest possible time, so that accommodations can be made for all penetrations of the shield. In this regard, every pipe, wire, door, air conditioning duct, etc., that passes through the shield must be considered and treated at the penetration point with the dielectric connectors outside the shield and wave-guided penetration specified. Every point of penetration shall be planned and indicated on the drawings with typical details of each type penetration.

(e) The design should limit, as much as practical, the number of penetrations. For example, if a sprinkler system is required, penetrate

17.8.16 Hospital Systems.

Hospital systems are very special designs, and specific requirements should be provided for each project. Hospital systems include Nurse Call, Central Dictation, Patient Monitoring, Radio and Public Address, CATV or MATV, Radio Paging Telephone, etc.

17.8.17 Process Control Instrumentation.

17.8.17.1 Design Analysis.

When project criteria require the design of a process control system, a detailed design analysis shall be provided at the earliest possible stage and shall be updated/revised at every submittal stage as more data and information are developed. The design analysis shall include the following information:

(a) All data, instructions, observations, etc., collected by the designer from site visits, meetings, conferences, etc., which are pertinent to design decisions;

(b) A detailed description of how each separate process operates, including inputs to process, additives to process, chemical reactions, times of processes and expected outputs, including concentrations and quantities;

(c) A description, similar to (b), of the overall process as each individual process relates to those before and after itself;

(d) A description of how each process will be instrumented to accomplish the individual and/or overall processes required in the system;

(e) An analysis and/or justification of why each device of instrumentation and control was selected in (d), instead of other available devices for the same function, and identifying and justifying sole source requirements;

(f) Calculations and/or data to justify decisions made; including, e.g., frequency analysis on control loops.

17.8.17.2 Drawings.

The drawings shall present simplified flow diagrams which follow the standard symbols and the examples given in ISA-S5.1 and S5.2 The locations of all components shall be shown on the drawings, and mounting details shall be shown for field equipment. The drawings shall show the locations and dimensions of control panels and consoles. When custom panels are to be fabricated, the locations of all components (meters, recorders, controllers, nameplates, etc.) shall be shown on the drawings, and mounting details shall be shown for field equipment. The drawings shall show the locations and dimensions of control panels and consoles. When custom panels are to be fabricated, the locations of components (meters, recorders, controllers, nameplates, etc.) shall be shown on the panel drawings. The routing of all electrical and pneumatic lines shall be shown. If the number of conductors and their characteristics, such as current and voltage ratings, shielding, etc., are known, the conduit size and the cable specifications should be shown. However, when the cable characteristics vary between equipment made by different manufacturers, the cable and conduit characteristics should be covered in the specifications.

17.8.17.3 Specifications.

The specifications shall be based on the MOB Guide Specification 16200 INSTRUMENTATION AND CONTROLS, supplemented as follows. The specifications shall present a functional specification of the total process and individual loops in order to clarify and specify process operation and performance. The level to which the Contractor is to tune and adjust the process should be clearly stated, along with tests and procedures to be used to demonstrate compliance with the functional specifications. In nonproprietary designs where the Contractor will have partial design responsibility through the selection of equipment to be installed and adjusted, the system performance shall be specified at the highest level consistent with the Contractor's control of the design. The minimum acceptable specifications of the individual system components, such as sensors, controllers, transmitters, etc., shall also be specified. Component performance specifications should reflect those criteria necessary for satisfactory and reliable operation of the system; e.g., accuracy, range, operating temperature ratings, etc.

17.8.18 Master Antenna Television Systems (MATV).

A thorough survey shall be made of the signal strengths for each channel available at the proposed site. The location of amplifiers and boosters shall be indicated to ensure proper signal levels throughout the system. Additional provisions shall be made for radiation-proof installation where leakage might interfere with other circuit transmissions. Channel selection for closed circuit TV operating on a coaxial cable system with a MATV system will be done to ensure there is no interference (adjacent channel, co-channel, etc.) with the MATV channels.

17.8.19 Cable Television Systems (CATV).

The CATV shall be a prewired system or a conduit system only for projects according to the criteria given. A two-inch (2") empty entrance conduit shall be installed for all projects for future installation of service cable by Using Agency. Provide a 3/4-inch plywood backboard with sufficient space for the distribution cable terminations, amplifiers, and splitters. The systems shall include cables from the backboard to each outlet, connectors on outlet plates and sufficient spare cable at backboard for future connection to splitters. All empty conduits shall have pull wires. Specifications will be included in Section ELECTRICAL WORK, INTERIOR.

17.8.20 Closed Circuit Television Security (CCTV) System.

The video security system, where required, shall be integrated into the overall function of the facility. The designer shall design a complete closed circuit television security (CCTV) system and shall have a minimum of 3 years experience in similar installations. Placement of cameras must be carefully considered in order to avoid dead zones. Conduit and wiring shall be installed for the system and a camera shall be installed at all entrance and exit areas. The location of the camera shall be suitable for monitoring people movement when entering or leaving the building and an emergency circuit shall provide power for each camera location. Conduit, wiring, cameras, etc., shall also be installed in all parking lots, loading docks, and computer areas to provide monitoring.

(1) Cameras shall be of the fixed or pan-tilt-zoom type as required for each specific location. Camera components shall include cameras, lenses,

fixed and remote-control camera accessories, camera housing, and environmental options. Cameras shall be housed in proper enclosures for the environment in which they are to operate (e.g., defrosters, heaters, weatherproof enclosures, corrosion resistant or vandalproof enclosures, etc.).

(2) All cameras shall be monitored/controlled at the facilities central control station. Monitors shall be event driven. Monitor components shall include monitors and monitor mounts. A VCR shall be provided where required, to record unauthorized access (control by guard). A 120 volt single duplex receptacle (emergency power) shall be provided immediately adjacent to all CCTV camera locations.

(3) CCTV cameras shall be provided to monitor entry and exiting from the loading dock areas. CCTV monitors (in addition to that at the central console for the loading dock areas), shall be provided in the loading dock office to provide identification of delivery vehicles prior to opening the loading dock doors.

208Y/120V 3-Phase 4-Wire LIGHTING PANEL   Panel: CB

Mains: 100A MLO   Feeds from: MDP
Trim: Flush   Min Sym IC: 10000
Neutral: S/N
Ground bar: No

PHASE LOADS

CIR	DESCRIPTION	TRIP	POLES	A	B	C	POLES	TRIP	DESCRIPTION	CIR
1	AHU-2	50	3	2904						
				500			1	15	SF-1	2
			-		2904					
					1167		3	15	EUH-1	4
			-			2904				
						1167	-			
3	AHU CONTROLS	20	1	1000						
				1167			-			
5	TBB	20	1		1000					
					1000		1	20	TBB	6
7	CATV BB	20	1			1000				
						1000	1	20	Receptacles	8
9	Receptacles	20	1	1000						
				400			1	20	Lights	10
11	Spare	20	1		500					
					500		1	20	Spare	12
13	Spare	20	1			500				
						500	1	20	Spare	14
15	Space only	--	1	---						
				---			1	--	Space only	16

Notes for CB:

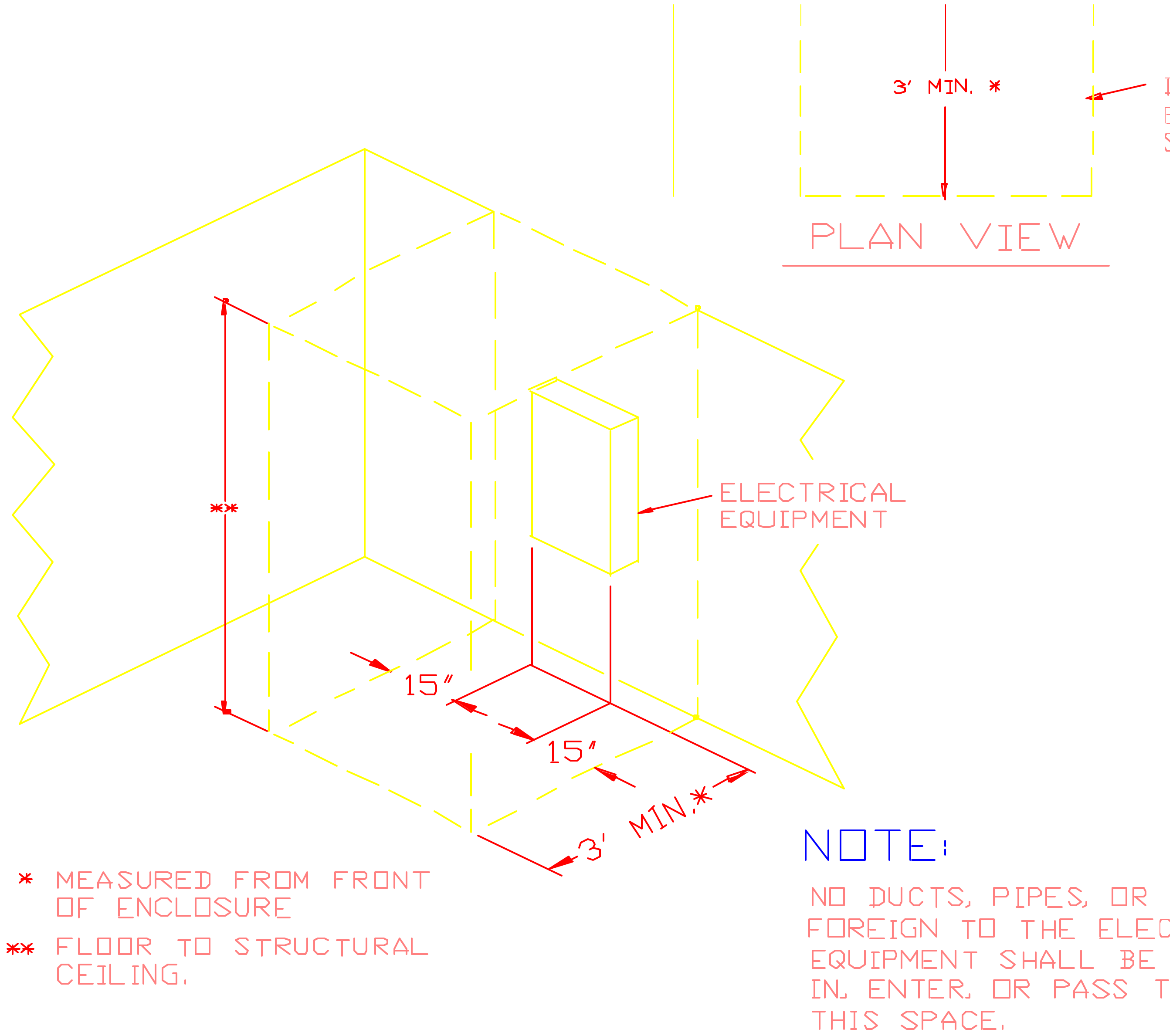
1 Provide GFCI breaker for circuit(s) 8

EXHIBIT 17-1

LIGHTING FIXTURE SCHEDULE

CONTRACT DRAWING FIXTURE SYMBOL	CORPS STANDARD TYPE	LAMP		FIXTURE			NOTE NO.
		QTY.	TYPE	MAX. WATT	VOLT	DESCRIPTION (INCLUDING OPTIONS)	

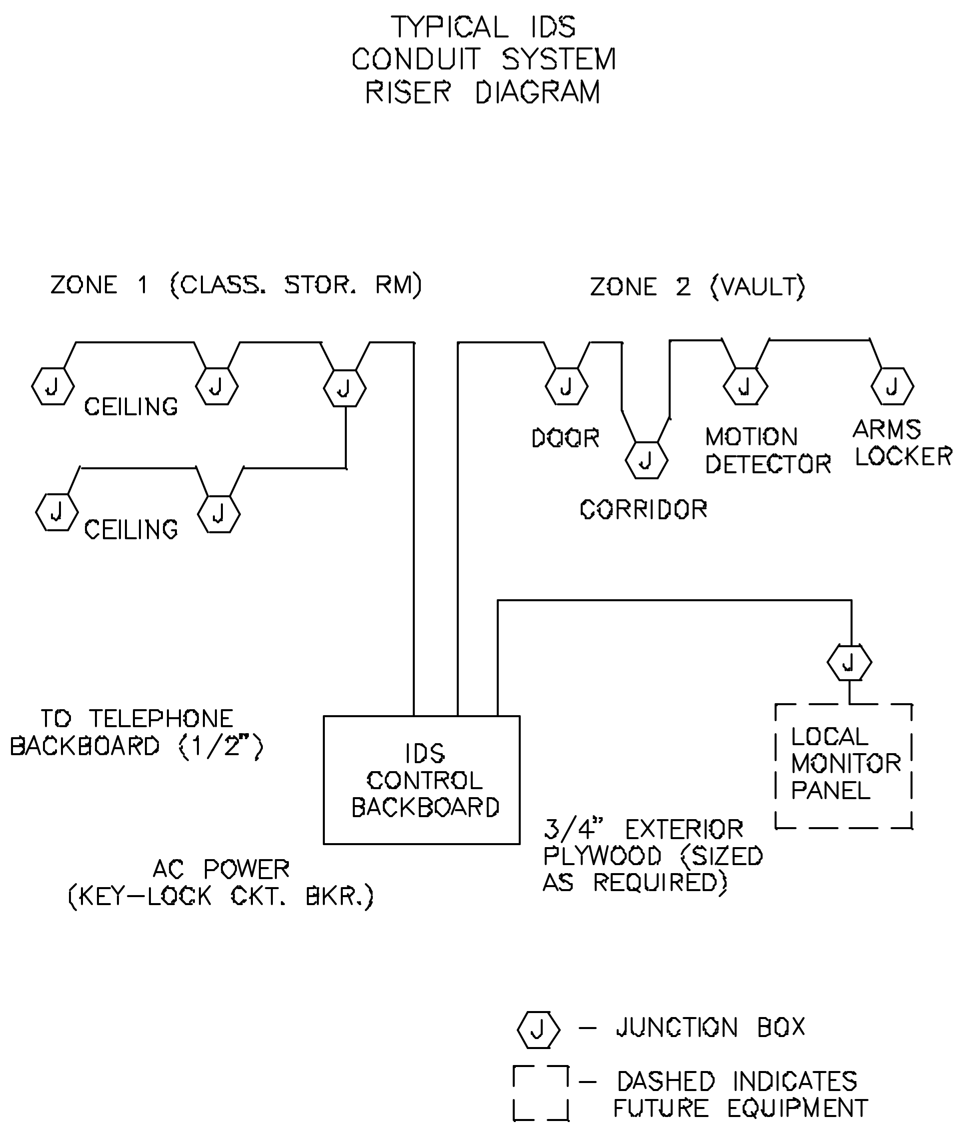
EXHIBIT 17-2



DEDICATED ELECTRICAL SPACE

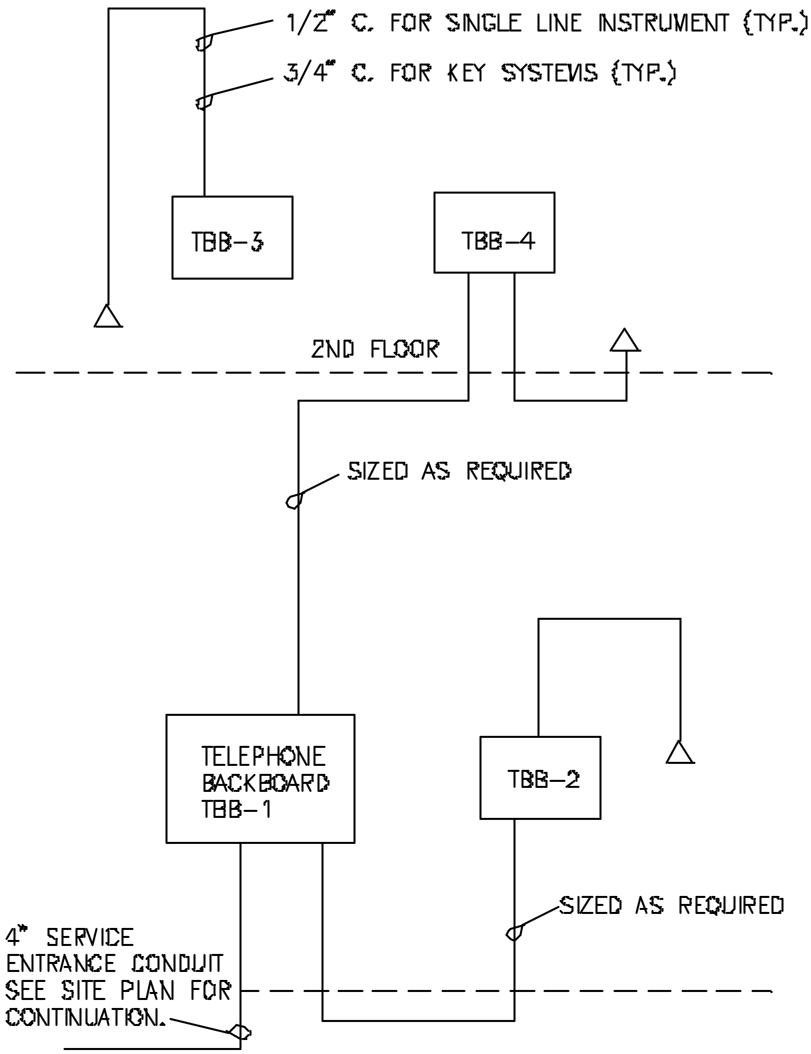
NOT TO SCALE

EXHIBIT 17-3



INTRUSION DETECTION SYSTEM RISER DIAGRAM

EXHIBIT 17-4

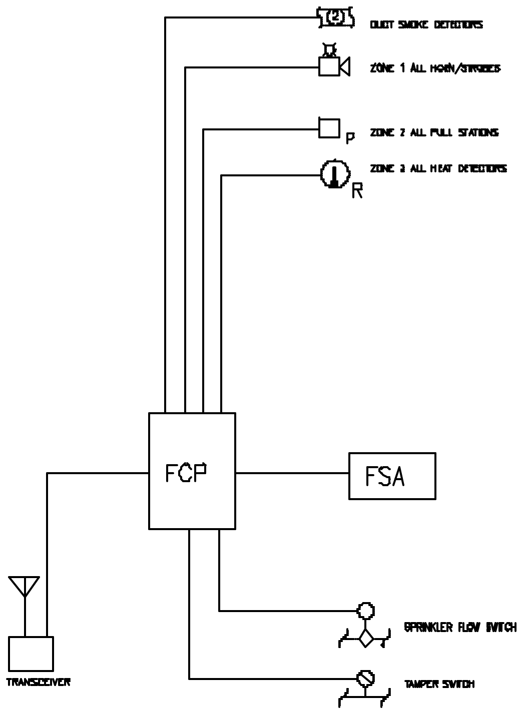


NOTE: LEGEND SHOULD COMBINED WITH LEGEND

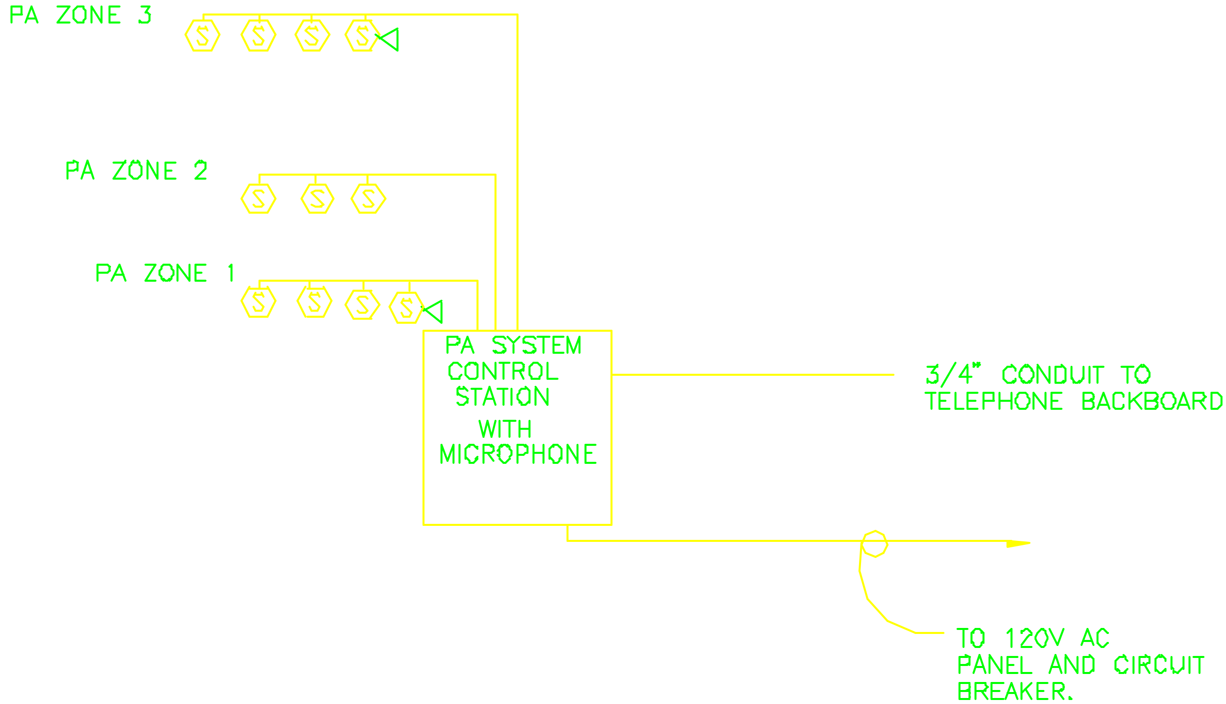
TYPICAL TELEPHONE SYSTEM RISER DIAGRAM

EXHIBIT 17-5

EXHIBIT 17-6



FIRE ALARM SYSTEM RISER DIAGRAM (TYPICAL)
NO SCALE



TYPICAL PUBLIC ADDRESS RISER DIAGRAM

N.T.S.

EXHIBIT 17-7

FIRE ALARM CHECKLIST

- REVIEW BASE SPECIFIC CRITERIA IN APPENDIX

- Determine what Codes and/or military requirements must be followed.

- Determine the type of system to be used. Check NFPA 72 and ADA to see if there are any special requirements.

- Initiating Devices

  - Manual pull stations.
    - Every egress.
    - Every level.
    - 200 ft. maximum horizontal travel distance.

  - Area detection
    - Protect ALL AREAS, including area above ceiling if needed. Consider providing a catwalk for maintenance of detectors in inaccessible areas. Consider remote LED for detectors above ceiling.

    - Place all detection devices at least 12-18 in. from lights and 3 ft. from HVAC diffusers on plans.

    - Heat detectors
      - If ceiling over 10 ft., reduce spacing.

      - If ceiling not smooth (interrupted by joists, beams), adjust spacing and mounting.

      - If ceiling not level (sloped), adjust spacing.

      - All points on ceiling within 0.7 times the listed spacing (after all adjustments).

    - Smoke Detectors
      - Use 30 ft. spacing as a guide.

      - If ceilings not smooth, adjust spacing and mounting.

      - If ceiling not level, adjust spacing.

      - All points on ceiling within 0.7 times the detector's listed spacing (after all adjustments).

      - Consider effects of stratification.

EXHIBIT 17-8
1 of 4

- SPECIAL APPLICATIONS

Use smoke detectors **under raised floors** and **above ceilings** if this area is used as a return air plenum. The detector must be listed for the air velocities present.

High air movement areas, see NFPA 72 5-3.7.6.1.

High rack storage areas, see NFPA 72 5-3.7.5 and Figures A-5-3.7.5 (a) and (b).

Smoke door release, see NFPA 72 5-11.7.

Elevator recall for firefighter's service, see NFPA 72 3-8.15 and ASME A17.1b.

- Flame detectors

- Duct Detectors
    - COORDINATE with Mechanical Engineer.
    - 2000 - 15000 CFM Detectors on supply.
      15000 or more CFM Detectors on supply and return.
    - Provide remote test station when detectors may be inaccessible.
    - Show detectors on floor plans and on fire alarm riser diagram.

- Notification Devices
    - Audible Alarms
        - Locate devices to provide sufficient sound level
            - 15 dB above ambient.
            - 5 dB above maximum for 60 seconds.
            - Double the distance and lose 6 dB.
            - Lose 25 dB through wall.
            - Lose 10 dB through door.

            CEGS lists following minimums measured at 10 ft.:
            - Bells 85 dBA.
            - Horns 85 dBA.
            - Chimes 80 dBA.
        - Provide device(s) on every floor.
        - Provide device(s) for noisy areas; i.e., Mech. Rooms and Break Rooms.
        - Devices in soundproof areas.
        - Devices in hallways to be heard when all doors closed.

EXHIBIT 17-8
2 of 4

- Devices to have distinct sound from surroundings.

- Visual Alarms
  - Space in accordance with Tables in NFPA 72, Chapter 6-4.4.
  - Note that there are different Tables for rooms, corridors (less than 20 ft. wide) and sleeping areas. There are also separate Tables for ceiling-mounted and wall-mounted appliances.

- Control Panel
  - Where a design will tie into an existing system, be certain that the new design will be compatible. Check existing wiring and FACP capacity.
  - For DC loop systems, put each of the following on an individual zone:
    - Fire Suppression System.
    - Hazardous areas.
    - Flow switches.
    - Tamper switches for post indicator valves (PIV's).
    - Tamper switches for all control valves.
    - Any other supervisory device.
    - Fireman's service for elevators.
    - Attic detectors.
    - Pull Stations
    - Kitchen equipment.
    - Notification appliances.
    - Automatic door release.
    - Power shutdown to data processing equipment.
    - AHU shutdown.

  - Provide manual override to AHU shutdown for testing purposes.
  - Activate fire alarms if a kitchen equipment control panel is alarmed, where applicable.
  - NFPA 72 lists maximum number of devices for a zone.
  - Consider maintenance when zoning detectors.
  - Annunciators
    - If an annunciator is needed, use a graphic annunciator. Annunciators that only list the zones merely repeat information available from the fire alarm control panel.
    - Do not forget to show underfloor detectors and detectors above raised ceilings.
  - Signaling Equipment
    - Make compatible with Base's existing system.

EXHIBIT 17-8
3 of 4

- Specify transceiver with enough zones to transmit facility.
- Do not show conduit to TBB when radio is used.

- Riser Diagram
  - Show FACP.
  - Power supply.
  - Signaling method.
  - Annunciator, if used.
  - ALL ZONES.

- Power Supply
  - Primary Source: Connections to light and power service on dedicated branch circuit, with disconnecting means accessible only to authorized personnel. Ensure that the disconnecting means is locked if necessary.
  - Secondary Source: Batteries most commonly used.
  - Trouble Source: Shall be independent of primary power.
  - Provide nonsupervised power for door holders.
  - All fire alarm devices should be powered from the FACP.
  - Show fire pump power ahead of all disconnecting means.

- Wiring
  - Wiring shall be Style D or Class A.
  - When connecting to an existing system, be sure that wiring is compatible. Do not connect a 4-wire system to a 2-wire system.
- Sprinkler System Electrical Supervision
  - COORDINATE with Mechanical Engineer and Sanitary Engineer.
  - Flow switches.
  - Tamper switches on <u>all</u> control valves and PIV's.
  - Pressure Tank: Detect high and low pressure.
    Detect high and low water level.
  - Dry-Pipe Pressure: Detect high and low pressure.
  - Steam Pressure: Detect low pressure.
  - Water Temperature: Signal when below 40 degrees F.
  - Fire Pumps: Supervise according to NFPA 20.

  - Show all supervising devices on floor plans and on fire alarm riser.
  - If an air compressor is used for the dry-pipe system, show it on the power floor plans with hard-wired power connection.

EXHIBIT 17-8
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CHAPTER 18

COST ESTIMATING

INDEX

EXHIBITS

CHAPTER 18

COST ESTIMATES

18.l GENERAL

The purpose of this chapter is to provide specific guidance for the preparation of cost estimates for military construction projects. Estimates are made for programming, cost control during design, evaluation of bids, control of negotiations, and to serve as a guide in establishing a schedule of payments. Often these estimates are also used to evaluate the reasonableness of the contractor's proposal for negotiated procurement contracts. As such, they must be consistent with the best estimating practice of the construction industry and be current, accurate, and complete. They must reflect the expected cost to the Government to perform the work by contract and include all reasonable costs which a prudent, experienced, and well-equipped contractor might anticipate and include in his bid.

18.2 APPLICABLE PUBLICATIONS

Air Force Parametric Cost Engineering System User Guidebook (PACES)
Civil Works Work Breakdown Structure
EI01D010, Engineering Instructions - Construction Cost Estimates
EP 1110-1-8, Volume 3, Current Edition - Construction Equipment Ownership and Operating Expense Schedule - Region III
ER 1110-1-1300, Engineering and Design Cost Engineering Policy and Requirements
ER 1110-2-1302, Engineering and Design Civil Works Cost Engineering
ER 1110-3-1300, Engineering and Design Military Programs Cost Engineering
ER 1110-3-1301, Engineering and Design Environmental Restoration Cost Engineering
Hazardous, Toxic, Radioactive Waste Work Breakdown Structure
MCACES GOLD User Manual, Volume I - Function and Capabilities & Volume II - Advanced Options
Military Work Breakdown Structure
National Unit Price Book, Region III, Current Edition

18.3 GENERAL INSTRUCTIONS

The Cost Engineer is responsible for obtaining the current version of all software and applicable user manuals. The recommended source is the Construction Criteria Base (CCB). The CCB resides on Compact Disk - Read Only Memory (CD-ROM) and is available by subscription from the National Institute of Building Sciences, Attn: CCB, 1201 L Street NW, Suite 400, Washington DC 20005; telephone (202) 289-7800. Note: Databases should be downloaded from the Internet (See below). The following is currently available from the CCB:

CCB Cost Tools Documentation

MCACES GOLD User Manual
MCACES GOLD Advanced Utilities Document
TRACES PBM User Information
Air Force Parametric Cost Engineering System User Guidebook

Executable Programs on CCB

MCACES GOLD (Micro-Computer Aided Cost Estimating Software)
PACES (Air Force Parametric Cost Engineering System)

The following supplemental cost estimating information required to complete the cost estimate is available on the Internet. The address for the Mobile District home page is - http://www.sam.usace.army.mil/sam/en/ /cost/encost.html. The following items can be downloaded off the Internet:

AF Form 1178 *(Blank Form)*
Cost Estimate Submittal Checklist *(Blank Form)*
Cost Growth Factors - Army
Air Force
Civil Works
Databases: Assemblies
Crews
Construction Equipment
Labor Rates
Models
Project Templates
Unit Price Book
Guide for Estimating Latin American Projects - Panama, El Salvador and Honduras
Guide for Estimating Payroll Taxes & Insurance and Sales Tax Costs (Stateside Projects Only)
HAG Data Sheet
Work Breakdown Structure: Civil
HTRW
Military

Projects will be designed in U.S. measurements or Metric measurements. When the project is a metric design, all units of measure and cost data referenced in this and other referenced documents for this project shall be changed to Metric Units of Measure and Metric Cost Data.

18.4 DELIVERABLES

The following items are to be included in estimate submittals which are to be reviewed by the Mobile District:

Cost Estimate Submittal Checklist (Required for all submittals). The checklist shall be filled in and used as a cover sheet for each cost estimate submittal. The Checklist can be downloaded off the Internet (See Paragraph 18.3 above). Access to each cost estimate and its contents shall be limited to those persons whose duties require knowledge of the cost estimate.

Estimate (Required for all submittals, number of copies specified in Appendix A, A-E Design Contracts). For manually-prepared, the complete detail and required summaries; for MCACES GOLD, all material printed out in accordance with the print settings in the "Project Template", in reduced size (8-1/2"x11"), landscape, and suitably-bound. The RTA cost estimate that is submitted to the Government shall be accompanied by a letter of transmittal which includes the following statement: "To the best of my knowledge the confidential nature of this estimate has been maintained". This statement should be signed, dated and maintained until the official markings have been removed.

AF Form 1178 (Required for all submittals on Air force Projects only), properly filled out in accordance with the instructions in paragraph ____ below. A blank AF Form 1178 can be downloaded off the Internet (See Paragraph 18.3 above).

1.44MB 3-1/2" Diskette(s) (required for all electronic submittals). The diskette will contain a electronic copy of the PROJECT DATABASE. No other related databases will be saved on this diskette. The LABOR RATES DATABASE shall also be saved to a separate diskette. The total number of diskettes needed depends on the size of the database(s) and storage capacity of the diskette(s). These databases shall be "SAVE TO COMPRESSED" diskettes from the SERVICES menu of the MCACES GOLD software.

Supporting Data (Required for all submittals). A suitably-bound, ordered and legible presentation of all cost estimate backup. Backup consists of Quantity Survey, Quantity Derivations and Quotations. **ALL BACKUP MUST BE TRACEABLE TO THE LINE ITEM TASK IN THE COST ESTIMATE THAT THE BACKUP SUPPORTS.**

HAG Data Sheet (Required with RTA submittal only). The HAG Data Sheet can be downloaded off the Internet (See Paragraph 18.3 above).

Annotated Comments, as appropriate.

NOTE: THE VARIOUS CUSTOMERS SPECIFIED IN APPENDIX A, A-E DESIGN CONTRACTS WILL RECEIVE THE "COST ESTIMATE PLUS AF FORM 1178, IF APPLICABLE" ALL THE OTHER ITEMS LISTED PLUS 1 EACH COST ESTIMATE (BOUND) AND 1 EACH COST ESTIMATE (UNBOUND) WILL BE PROVIDED TO THE MOBILE DISTRICT COST ENGINEERING BRANCH ONLY.

18.5 ESTIMATOR QUALIFICATIONS

The designers cost estimating staff shall consist of dedicated full-time cost engineering specialist(s) for each required design discipline, such as architectural, structural, civil, mechanical, and electrical. It is imperative that estimates be prepared by, and reviewed under the supervision of, personnel who are competent in construction cost estimating. Estimators must possess a working knowledge of construction and be capable of making professional determinations based on experience. If the designer determines his staff does not possess all these qualifications, he shall obtain assistance from a qualified firm whose specialty is cost estimating. In making this determination, the designer shall consider the complexity of the project and the number and qualifications of his full-time estimators. In consideration and selection of a consultant firm for cost estimating, the designer shall consider, in addition to the foregoing, the firm's specialties, its ability to coordinate the estimates with the designer, and its previous experience in preparing cost estimates for the Government. Estimates prepared by a consultant must be reviewed by the designer before submittal to insure coordination and compliance with contract requirements.

18.6 METHODS OF ESTIMATING

18.6.1 General

The method(s) used to prepare estimates for the various required submittals shall be as specified in the Statement of Work-Cost Estimating Criteria. Method specified may be the Micro-Computer Aided Cost Engineering System (MCACES GOLD Edition), Tri-Service Automated Cost Engineering System (AF TRACES Parametric Building Models - PACES), Manual Method or Excel Spreadsheet Method as described below, or a combination of MCACES and TRACES. **REGARDLESS OF THE METHOD USED, THE DESIGNER SHALL MAKE ALL NECESSARY INVESTIGATIONS, EVALUATIONS, CALCULATIONS, AND ADJUSTMENTS TO INSURE THAT ESTIMATES FIT THE SPECIFIC PROJECT SCOPE AND CONDITIONS AND ARE CURRENT, ACCURATE AND COMPLETE. ABSOLUTELY, NO OTHER METHODS (COMPUTERIZED SOFTWARE, SPREADSHEET, TYPED, ETC.) WILL BE ALLOWED WITHOUT SPECIFIC APPROVAL IN ADVANCE PER PROJECT FROM THE MOBILE DISTRICT COST ENGINEERING BRANCH (334-690-2626).**

18.6.2 TRACES (AF TRACES Parametric Building Models)

When the TRACES (AF TRACES Parametric Building Models) system is specified, the estimate shall be prepared as explained in the Statement of Work-Cost Estimating Criteria and the TRACES User Manual and Site Work Model Report. Further detailed instructions and specific information will be provided separately as necessary.

18.6.3 MCACES GOLD

Under the MCACES GOLD procedure, the estimate shall be prepared as explained in the Statement of Work-Cost Estimating Criteria and the MCACES Gold User Manual. Further detailed instructions and specific information will be provided separately as necessary.

18.6.4 Manual

When the manual procedure is directed or elected for a specific submittal, the estimate shall be prepared similarly to the sample final estimate which will be furnished if applicable. At the Ready-To-Advertise submittal, the estimate forwarded to the Mobile District shall be the original, prepared in pencil, in order that any necessary revisions by the Government may be readily made.

18.6.5 Excel Spreadsheet

When the Excel Spreadsheet method is directed, the estimate shall be prepared on the Excel Spreadsheet blank forms and similarly to the sample Excel Spreadsheet final estimate which will be furnished if applicable. Further detailed instructions and specific information will also be provided separately as necessary.

18.7 SUBMITTAL REQUIREMENTS

18.7.1 General

The designer shall prepare (or have prepared by an estimating consultant) a professional quality construction cost estimate at each of the various stages of project design. Estimates must accurately reflect the scope and features of work shown on the design documents actually submitted. The degree of detail must be commensurate with that represented by the submitted plans, specifications, design analyses, etc. Where the design is not sufficiently complete to enable accurate definition of any portion of the work, appropriate allowances, based on good estimating experience and judgement, must be made to cover work not yet fully defined.

18.7.2 Cost Control

Funds for project construction are usually programmed based on the estimated cost at the project definition or concept design stage. Based on the programmed amount, which frequently cannot be increased, a Construction Cost Limitation (CCL) is determined. The designer is responsible for making every reasonable effort to design a project that can be built within the CCL, specified in the Statement of Work (SOW). Throughout the entire design period, close coordination between the designer and cost engineer must be exercised to achieve accurate cost control.

18.7.2.1 Cost Estimate Overruns

It is the designers responsibility to design the project so that the current construction costs including project escalation costs are within the construction cost limitation specified in the SOW. However, if for some reason beyond the designer's control the project should exceed the construction cost limitation, the designer shall submit the following: (1) the cost estimate showing a base bid that is equal to or less than the construction cost limitation; (2) identify a list of additives alternates/options to bring the total bid package to no more than the construction cost limitation specified, that have been coordinated through the Mobile District Corps of Engineers Project Manager (PM); and (3) a written narrative explaining the reasons why the current construction costs including project escalation exceeds the construction cost limitation specified. A written narrative shall also be submitted whenever the current cost estimate has changed more than 5% (plus or minus) from the previous cost estimate. In the case of the project definition or concept cost estimate, variations from the DD Form 1391 shall be explained in narrative form.

18.7.2.2 Failure to Comply with Procedures

Failure of the designer to conform to the procedures outlined within this or referenced manuals will result in the estimate being rejected and resubmitted with deficiencies corrected and the designer may be required to come to the Mobile District office within 48 hours for a face-to-face meeting for the purpose of preparing a corrected cost estimate.

18.7.3 Format

18.7.3.1 General

When TRACES or MCACES GOLD is specified, the format will be as outlined in the Statement of Work-Cost Estimating Criteria. The Cost Estimate shall also follow the Tri-Services Work Breakdown Structure (WBS). In addition, a Work Breakdown Structure hierarchy (Normal, Full, Partial or Special) has been established for all M-CACES Gold projects. Project information shall be input so that the estimate output will present costs for the building (or primary facility), broken down according to its various features, and costs for all support items. Any bid schedule, money allocations, etc. requirements shall also be considered. The TRACES system, after project/facility data has been established, models selected, project parameters defined, quantities and direct costs calculated, modifiers (overhead, profit, escalation, contingency, and SIOH) added, the system will generate various construction cost reports. The MCACES system, after project unit prices, assemblies, models, labor rates, construction equipment rates and crew data is input, will compute costs and produce the estimate. When an estimate is manually prepared, its format shall conform to the example provided, with similar breakdown of features and bid items. When an estimate is prepared using the Excel Spreadsheet method, its format shall also conform to the example provided, with similar breakdown of features and bid items.

18.7.3.1.1 Military Projects

The Military WBS as specified in Section 18.11 will normally be used on all Military Construction Projects.

18.7.3.1.2 Civil Works Projects

At the Reconnaissance Study or alternative evaluation phase of Feasibility Studies, rough-order-of-magnitude estimates based on historical costs can be prepared manually or using an Excel spreadsheet. Once a selected plan is determined a detailed MCACES GOLD estimate must be prepared using the appropriate Civil Works Work Breakdown Structure (WBS) format. After the detailed MCACES estimate is prepared a Total Project Summary of Costs must be prepared using an Excel spreadsheet. This summary must be arranged by Code of Accounts format and include all project costs (e.g. Real Estate, Design, Engineering During Construction, etc.) and show the appropriate escalation.

At the Plans and Specifications (P&S) stage all estimates must be prepared using MCACES and detailed equal to the level of design. The MCACES estimate should be arranged according to the project Bid Schedule included in the specifications and be formatted in the Civil Works WBS. The Total Project Summary of Costs must also be updated at this stage to reflect the current estimates.

At the RTA stage, the Government Estimate must be arranged according to the Bid sxchedule shown in the solicitation specifications. The Government Estimate must be prepared using MCACES to a level of detail commensurate with the solicitation drawings. The Government Estimate does not include Prime Contractor Profit.

For Civil Works Projects involving dredging, the cost estimate should be prepared using the appropriate CEDEP spreadsheet program in lieu of MCACES for the Dredging Account only.

18.7.3.1.3 HTRW Projects

HTRW Environmental Restoration Projects shall use the HTRW WBS. The HTRW WBS provides the framework for preparing cost estimates, modeling development, and collecting historical data for all remediation projects. The WBS consists of a numbering and title system that details the work to four levels of the WBS to organize the HTRW estimate. As a minimum, all estimates shall be prepared to the fourth level followed by detail. The quantity take-off shall be prepared following the WBS to the same level. In no case shall the WBS title descriptions be changed for levels one through four. Levels five and six are optional. New titles for work not covered in the WBS may be added under numbers 90 through 99. Maintaining this rigid structure for the first four levels will allow systematic collection of historical HTRW costs. Any vertical building construction required within the HTRW project shall be a separate estimate from the environmental work and shall follow the Military WBS. HTRW projects will likely have two distinct phase; construction of a treatment facility and operation and maintenance of the facility over a period of time that may range from months to years. Construction and operating wage rates, escalation rates, and other cost may be different for construction vs. long-term plant operation. Therefore, construction costs will be prepared in a separate estimate from the “after construction” operations cost. Depending on the project scope, it is possible the designer will be required to prepare three (3) separate estimates for each submittal. One for the vertical building construction, one for the HTRW construction, and one for plant operations.

18.7.3.2 Bid Schedule

For Project Definition submittals, estimated contract costs shall conform to a bid schedule similar to that expected to be developed later, with a minimum of at least one bid item for work within any building and at least one to cover exterior work. For later than concept submittals, estimates shall conform to an acceptable bid schedule proposed by the designer. Generally, each different building or building type must be covered under a separate bid item. Within a building, selected features or work items may be required to be covered under separate bid items for cost accounting or other reason. Exterior work may be required to be broken into separate bid items where quantities of work are significant and highly variable or where useful historical cost data can be derived from analysis of bids received. The estimate shall present a total amount for each bid item to include direct labor, material and construction equipment costs, indirect costs and profit. The final bid schedule will be as directed or approved by the Government. If the estimated cost of the total project, including cost growth allowance, would exceed the CCL, it may be necessary that the bid schedule include items under a base bid and additive alternates /options. Where additional bid item breakdown beyond that proposed by the designer is considered necessary, it shall be provided by the designer at no additional cost to the Government. Guidance regarding bid item breakdown may be obtained by contacting the Mobile District Military Cost Engineering Unit. Estimates for modifications under an existing construction contract must conform to the contract pay item schedule. When the Statement of Work requires multiple Bid Schedules, preparation of separate detailed cost estimates and associated summaries is mandatory.

18.7.3.3 Contractor Type

The estimate shall be structured according to the type contractor considered most likely to bid as prime. For example, if the job is so heavy in mechanical work that most bidders would likely be mechanical contractors, the estimate should reflect a mechanical prime contractor.

18.7.4 Cost Breakdown

18.7.4.1 General

Costs must be broken down into priceable elements. All cost and quantities in the estimate must be supported. **Unsupported lump sum pricing is not acceptable at any stage of design**. The level of breakdown must be commensurate with detail available from the design documents.

18.7.4.2 Project Definition (10-15%)

The Project Definition Cost Estimate should be as detailed as the level of design will permit. Unit pricing which includes all direct labor, material and construction equipment costs and any subcontractor markups is permitted, provided appropriate support is included. Prime contractor indirect costs and allowance for profit must be excluded from such unit prices and added separately.

18.7.4.3 Concept Design (30-35%)

The Project Definition Cost Estimate should be as detailed as the level of design will permit. Unit pricing which includes all direct labor, material and equipment costs and any subcontractor markups will be permitted up through the concept submittal, provided appropriate support is included. Prime contractor indirect costs and allowance for profit must be excluded from such unit prices and added separately.

18.7.4.4 Interim Design (50-60%)

The Interim Design Submittal Cost Estimate shall be prepared in task-by-task detail to accurately reflect the scope of work shown in the submittal. This cost estimate provides good cost control prior to final design.

18.7.4.5 Final Design (Unreviewed 100%)

The Final Design Cost Estimate shall be prepared in task-by-task detail to accurately reflect the scope of work shown in the submitted documents. At the Final submittal, since design is complete, the scope of work is defined sufficiently well to permit accurate and complete determination of all project costs.

18.7.4.6 Ready-to-Advertise (100%)

At the final submittal, a final update of the Final submittal, the estimate will be comprised entirely of work tasks for which basic costs are detailed. The designer is responsible for the complete cost estimate including amendments that might occur during the advertising period.

18.7.5 Resubmittal and/or Support

If upon review, any submitted estimate is found to not be in compliance with any of the requirements stated or referenced in these instructions, it will be rejected. The designer shall, promptly upon request, revise and resubmit the estimate in the time specified in the resubmittal notice, with deficiencies corrected, at no additional cost to the Government. If cost, quantity, etc., of any item in the estimate appears questionable, the designer shall promptly provide sufficient and satisfactory explanation and/or supporting data.

18.7.6 Bid Exceeds Estimate

After all bids are received and they are significantly higher than the Government Estimate to be determined unreasonable, there is a possibility that one or more bidders will protest the reasonableness of the Government Estimate. In addition, the designer/cost consultant Final Bid Price Estimate may not be within 15 percent of the low responsive bid at bid opening time. If this occurs, the designer has a major role in reviewing the Government Estimate and evaluating the Government's position. The designer/cost consultant will promptly conduct an independent review of the

Government estimate at no additional cost to the Government. The responsible cost engineer would review the Government Estimate to be sure that it does not contain any omissions, discrepancies (errors in calculation, etc.), quantity takeoff errors, or errors in cost/pricing data. In addition, the reviewer should further analyze any unusual conditions or circumstances that may affect or complicate the work. If the reasonableness of the Government Estimate is protested, the analysis will consist of an in-depth, point-by-point response to all issues raised by the protestor or contractor. The review/analysis will consist of the Government Estimate, including all backup and supporting data, complete explanations about assumptions made and, if available, historical data from previous similar projects which support the estimate. The Government Estimate should be revised immediately if an error is found, and an explanation of the error should accompany the revised estimate. If the revised estimate brings an offeror's price within range of a fair and reasonable price, the Contracting Officer will review the situation and determine final contracting action.

The designer is required to accomplish the design to permit the award of a contract at a price that does not exceed the construction cost limitation specified. When bids for the construction contract exceed this amount, the Mobile District may enforce the contract clause requiring the designer to perform such redesign necessary to permit award within funding limitations. These services shall be performed at no increase in the cost to the Government.

18.8 TECHNICAL REQUIREMENTS

18.8.1 General

Estimates must accurately reflect the project scope and conditions, local labor situation and prices of material, labor, and construction equipment anticipated or forecast to prevail in the project vicinity at the time of construction, based on a practicable construction schedule. The estimate should consider delivery dates for materials and equipment to be installed. Estimates will not be accepted as meeting contract requirements if data used in their preparation is substantially different from that shown on the submitted drawings or other design data. Very close coordination and clear communication among the designers and estimators is required because reliable, accurate estimates cannot otherwise be produced.

18.8.2 Quantity Survey

Accuracy and completeness of the quantity survey (takeoff) is essential as it directly and critically affects the accuracy of the estimate. The takeoff shall be comprehensively and accurately prepared to cover all work for the project. It shall be based on all facts that can be gathered from the available engineering and design data. Assumptions as to detail which is beyond the level available at the current stage of design is often necessary to insure that total cost of the overall project work is covered. In such cases, statements and explanations of necessary assumptions shall be included so that, when design details become available, quantities can be reconciled. Quantity surveys must be planned to fit the pricing for the work involved, conform to the bid schedule, and be consistent with the payment provisions of the specifications. Surveys must be documented in such manner that computations can be later followed and verified by others. Tabulation and computation sheets shall be dated and contain appropriate references to plans, specifications, or design analyses. Relevant sketches shall be included. Quantity survey documentation must be furnished as a part of the estimate submittal to be reviewed by the Mobile District Cost Engineering Branch.

18.8.3 Material Pricing

When an item of material is relatively minor or not yet fully defined, as at concept or earlier stage, it may be satisfactory to base pricing on data in estimating handbooks (including the MCACES Database). In these cases, appropriate adjustments must be made to account for project conditions. For later stages or for significant items, material costs will be based on verbal or written quotations obtained from manufacturers and suppliers, price lists appropriately discounted, and previous recent quotations. Specific current price quotations (at least two, if practicable) should be obtained for major items of permanent equipment and for significant, unusual or nonstandard material items. Where quantities or unit costs will have only moderate impact, recent reliable quotations from other projects for comparable items are considered acceptable. Freight costs to the project site must be covered. Sales and other applicable taxes must be included in the estimate by applying, in a separate calculation, appropriate percentage markups of material cost. Guide for Estimating sales Taxes can be downloaded off the Internet (See Paragraph 18.3 above). Each submittal for which quotations are appropriate shall include a list showing principal items of material, equipment and supplies (such as concrete, structural steel, siding, pumps, chillers, uninterrupted power system, etc.), and indicating the manufacturer/supplier, location, person contacted, telephone number, date, pricing, etc., along with all other pertinent information collected or prepared for the estimate. A record of the pricing data utilized must be maintained and submitted as backup data with the estimate to be reviewed by the Mobile District Military Cost Engineering Unit.

18.8.4 Labor

18.8.4.1 Wages

Labor costs in the estimate must be based on rates that include basic wages, overtime and holiday premium payments, and Contractor's contributions for fringe benefits such as health and welfare, holiday and vacation pay, pension fund, apprentice training, etc. Estimated rates should be those which the contractor will be expected to pay when the project is actually constructed and must consider prevailing rates actually being paid in the project area as well as minimum rates which will be included in the contract in accordance with the requirements of the Davis-Bacon Act. Information on wages may be available from various sources, such as Corps field offices, Mobile District Cost Engineering Branch, contractors in the project area, etc. Ultimately, the designer is responsible for all wage rates used in the cost estimate.

18.8.4.2 Unit Costs

18.8.4.2.1 General

Labor unit costs should be based on estimated productivity and cost of wages, fringe benefits, etc. for the labor involved. Productivity estimates are based on experienced rates, tempered by estimators' judgement and must consider project conditions, labor availability, market conditions, and the like. Useful information can be obtained from vendors, subcontractors, and other pertinent sources.

18.8.4.2.2 TRACES

TRACES does not use specific project location wage rates to develop unit costs, but uses location modifiers to adjust material, labor, and construction equipment costs based on the location of the project. However, TRACES scope and cost can be exported to MCACES GOLD where specify line items can be adjusted.

18.8.4.2.3 MCACES GOLD

For MCACES GOLD estimates, labor unit cost is a function of the crew unit cost and the value for crew daily output included for each task. The productivity rates in the MCACES GOLD Database must be adjusted for project conditions as appropriate.

18.8.4.2.4 Manual or Excel Spreadsheet

Productivity must also be carefully evaluated for Manual or Excel Spreadsheet estimates. For mechanical and electrical work, labor cost must be estimated by assigning unit manhours to each task, then applying an appropriate prevailing wage rate to the summarized manhours. For work other than mechanical and electrical, labor may generally be estimated by applying to each task a realistic unit cost (based on a reasonable task productivity and current prevailing wage rates), unit manhours, unit crewhours, or as directed. Where the labor cost for a specific task in a manually-prepared or Excel Spreadsheet prepared estimate is significant, or the task has unique requirements, the submittal should include a detailed estimate based on productivity and cost of an appropriate crew similar to the example provided.

18.8.4.2.5 Social Benefits Cost

The contractor's cost for Social Security taxes (FICA), Federal and State Unemployment Insurance, Workmen's Compensation and Employer's Liability Insurance and any other social benefits must be included in the estimate as a percentage of the labor costs. Guide for Estimating Payroll Taxes & Insurance can be downloaded off the Internet (See Paragraph 18.3 above).

18.8.5 Construction Equipment

TRACES does not use specific project location construction equipment costs, but uses location modifiers to adjust material, labor, and construction equipment costs based on the location of the project. For MCACES GOLD estimates, costs for construction equipment and small tools costs are included in the equipment rates database. These costs are thereby included by the system for each task, as appropriate. For manually-prepared or Excel Spreadsheet estimates, costs shall be computed similarly to the crew method of MCACES GOLD and included in the detail for the work item to which it pertains. EP 1110-1-8 is the basis for MCACES GOLD construction equipment unit costs and shall be used as well for estimating construction equipment costs for manual or Excel Spreadsheet cost estimates. Sometimes extraordinarily large numbers, or highly specialized, unusual or unique items of construction equipment may be required to construct a project. In any instance where it is considered likely that the Contractor would have to rent certain construction equipment, rental rates should be determined for those items and appropriate adjustments included in the cost estimate to cover any additional cost.

18.8.6 Subcontract Work

Estimates shall be prepared for subcontract work using the same methodology and degree of detail for direct costs as outlined for work by the prime contractor. **All Subcontractor work must be detailed. Subcontractor quotations in lieu of detail is unacceptable.** The subcontract estimate shall include costs for direct labor, materials, equipment, and second-tier subcontracts, as well as subcontractor mobilization and other indirect costs and profit. A subcontractor's overhead usually bears a fairly stable relationship to the subcontractor's portion of the work and can be estimated on a percentage basis. Overhead rates typically range from 10 to 15 % and profit rates from 7 to 10 %, depending on complexity, risk, etc., and judgement must be exercised in selecting appropriate rates. For second-tier subcontract work, overhead and profit markups must be covered for second-tier as well as first-tier. A detailed derivation of subcontractor's overhead costs will be required where his work has unique requirements or where the cost impact of the subcontracted work is significant. When reliable subcontractor quotations are obtained, they may be used to verify the reasonableness of the estimate for the subcontract work.

18.8.7 Mobilization and Demobilization Costs

These costs must be estimated by detailed analysis considering equipment requirements, distance to move to project site, transportation methods, effort required to prepare, service, load, unload, etc., and the detail included in the submittal. For most building-type projects, mobilization and demobilization for the prime Contractor may be included in the estimate of indirect costs. Subcontractor mobilization and demobilization cost should be included in the estimated subcontract total. Where costs apply primarily to certain work items, e.g., for specialized equipment, they should be appropriately distributed to applicable items.

18.8.8 Indirect Costs

18.8.8.1 General

For concept or earlier estimates where direct cost items may be estimated by experienced unit prices, use of empirical markups for prime contractor is acceptable. For later-than-concept estimates, all field indirect costs for the project must be estimated in detail and then distributed logically to the various items in the bid schedule. Home office expense will normally be prorated to all bid schedule items.

18.8.8.2 Field Indirect Costs

These include such costs as those for field supervisory, administrative, and technical personnel, offices, shops, yards, utilities, communications, office and engineering supplies and equipment, etc. expected to be incurred at the project site but not chargeable to a specific work item. Exhibit 18-1 lists some items of field indirect cost. The list is not all-inclusive but is indicative of the type costs which are to be considered.

18.8.8.3 Home Office Expense

These costs will typically be included in estimates by applying an estimated percentage to the expected total field (direct plus indirect) cost amount. A contractor's home office expense rate is not fixed but varies from period to period. It is considered a function of his total general and administrative expense for a specific period divided by his total field costs for that same period. A reasonable average range of rates is estimated to be from 2% for larger to 7% for smaller contractors.

18.8.9 Profit

The estimate shall include appropriate allowances for profit. For the prime Contractor and for subcontractors whose work is a significant portion of the project, rates for profit allowance will be determined by the Weighted Guideline method (Exhibit 18-2). For less significant subcontract work, experienced percentage rates may be used.

18.8.10 Bond

Costs for performance and payment bonds shall be included in the estimate. Specific rates are dependent on factors such as the type of work to be performed, the contract amount, and the time allowed for completion.

18.8.11 Contract Modification Estimates

In certain instances, the designer will be tasked to prepare estimates for a modification to an ongoing construction contract. Such estimates are used as a basis of negotiations with contractors for additions to or deletions from a project, or both, and shall be carefully prepared in accordance with the applicable instructions in this chapter, as well as any supplemental information or instructions to be furnished by the Mobile District Military Cost Engineering Unit. Discussions with the Mobile District Military Cost Engineering Unit prior to preparation of the contract modification cost estimate is mandatory.

18.8.12 Current Working Estimate (CWE)

The CWE is defined as the latest available cost estimate for a particular project and should represent, as closely as possible, the total expected cost to construct the project. It must include the estimated contract cost as of the date of preparation, an allowance for cost growth (Current Cost Growth Factors can be downloaded off the Internet - See Paragraph 18.3 above), as applicable, an amount for contingency reserve to cover unforeseen developments during the actual construction which will result in additional costs, and an allowance for Government supervision and administration (S&A). To account for any cost increases which are anticipated to occur between the estimate preparation date and the actual construction period, an allowance for cost growth must be made. This will ordinarily be accomplished by the use of a percentage factor developed from a cost escalation index. Guidance for construction contingency allowance and S&A costs are outlined in the Statement of Work-Cost Estimating Criteria.

18.8.13 Quality Assurance

See Exhibit 18-3 Technical Quality Control Checklist. This checklist may be used by the cost engineer to ensure the cost estimate submittal is complete.

18.8.14 Supplemental Information

Additional specific information and guidance will be furnished as appropriate for projects which are unique or unusual or for projects outside the Continental United States.

18.8.15 Clarification

Should any question arise concerning the requirements, instructions, procedures, etc., described herein, the Mobile District Cost Engineering Branch (334-690-2626) should be contacted for explanation and clarification.

18.9 SCOPE

Estimates shall be based on the most recent and complete design information available and shall follow the format of the appropriate Work Breakdown Structure (WBS). There are three (3) separate Work Breakdown Structures: Military, Environmental Restoration, and Civil Works. The Military WBS shall be used for all vertical building construction whether Military, Environmental or Civil Works funded. Environmental Restoration projects shall use the Hazardous, Toxic, Radioactive (HTRW) WBS (funded by DERO, Superfund, DOE, etc.). The Civil Works WBS shall be used for large earth moving/dredging projects normally funded with non-military funds.

18.10 SPECIFIC INSTRUCTIONS.

The designer will be provided the following information.

18.10.1 MCACES GOLD User Manual, Volume I - Functions and Capabilities; Volume II - Advanced Options. See Paragraph 18.3 above.

18.10.2 MCACES GOLD Software, Current Version. See Paragraph 18.3 above.

18.10.2.1 General

The designers computer will have to be configured properly and have sufficient disk space available (see MCACES GOLD User Manual, Volume I, Appendix A) before installing the software.

The MCACES GOLD software shall be installed as provided following all instructions. The designer shall work through the MCACES GOLD User Manual and become familiar with the program. The designer shall use the installation instructions provided in the manual. Some of the databases may be in a “Protected Mode” and the user cannot edit these databases. Once items from these databases are brought into the project, they may be edited to reflect conditions for that project. Specific Project Templates are provided via the Cost Engineering Branch Internet address, and shall be used to create the project. The Project Templates provided already have the structure set. Working Appendix A, “Learning GOLD”, will help in getting familiar with the software. THE DESIGNER MUST USE THE MCACES GOLD SOFTWARE SPECIFIED FOR USE BY THE MOBILE DISTRICT FOR THIS PROJECT, AND NO OTHER MCACES GOLD SOFTWARE.

All databases provided are FOR OFFICIAL USE ONLY and shall be protected accordingly.

ASM94A - 17 Building Assemblies Library
CWSA95 - Civil Works Smart Assemblies
HTWASL - HTRW Assemblies Library
HTWEXM - HTRW Estimate Example - Bid Form
HTWTMP - HTRW Template - Bid Form
CIVWB3 - 1994 Civil Works Work Breakdown Structure
CIVWB4 - 1994 Civil Works Checklist
FIELDO - Job Office Overhead Model
HTWWB3 - HTRW Remedial Action Work Breakdown Structure
HTWWB4 - HTRW Remedial Action Work Breakdown Structure
TRACES - TRACES Work Breakdown Structure
MDL92A - 44 Building Model Library
- Unit Price Book (Current Edition)
- Labor Rates (Note: Specific Locations Listed)
- Crews Database (Current Edition)
- Equipment Database (Current Edition)

Explanation can be found in the MCACES GOLD User Manual. Both the Assembly and Models databases contain similar information, which are a few generic type assemblies. Some of these assemblies may be close to your requirements and may be copied to a new assembly ID and edited to create a new assembly to be used in your project. The ASSEMBLY DATABASE ID is ASM94A, and the MODELS DATABASE ID is MDL92A.

Note: Assemblies and Model Databases may not be used for Later-Than-Concept submittals. However, they may be used for Design-Build projects.

18.10.3 Labor Rates Database

If available, current wage rates to be used in preparing the construction cost estimate will be provided to the designer. The furnished wage rates will be generic and will normally reflect the Davis-Bacon minimum wage rate determination. The designer is responsible for addressing any abnormal circumstances required by the project and making corrections to the database wage rates provided. If no current wage rates are available, it is the designer's responsibility to fully investigate and determine proper wage rates. Using the localized LABOR RATES DATABASE, will put the correct labor and unit cost into the project. As the units of work are brought into the PROJECT DATABASE they are repriced with the currently selected LABOR, EQUIPMENT and UPB (material only) DATABASES. The labor and unit cost shown in the UPB, CREW and ASSEMBLY DATABASES will not show the same cost when brought into the project because these databases have not been repriced to the localized LABOR RATES DATABASE. See Guide for Estimating Payroll Taxes & Insurance and Sales Tax Costs (Stateside Projects Only) - Reference Paragraph 18.3 above..

18.10.4 Sample Projects

Sample Projects are provided for review of the required format for the Civil, HTRW and Military type of estimates prepared by the U.S. Army Corps of Engineers. All databases are compressed and can be loaded from within the MCACES software using "LOAD FROM COMPRESSED" on the SERVICE Menu. All Sample Projects may be loaded into the \GOLD\PROJECT\ directories. The following Sample Projects are available via the Cost Engineering Branch Internet (See Paragraph 18.3 above) address:

CIVEXM - Buffalo Bayou Sample Estimate
DEMAIR - Air Terminal Reconstruction
HTWEXM - HTRW Example Estimate
MILEXM - Storage Building Example Estimate

18.10.5 Templates

Templates shown below are used to start the respective project. For Military Estimates the "MILTM2","MILEX1" or "MILEX2" Template (depending on the WBS specified) is to be used to create the estimate format. For Civil Estimates use the "CIVTMP" template, and for HTRW Estimates use the "HTWTMP" template. Use "LOAD FROM COMPRESSED" on the SERVICES Menu to load the required template into the \GOLD\PROJECT\ directory. Use "COPY A DATABASE" from the SERVICES Menu to copy this project template into a unique six-character project ID. The templates are not to be used for entering data. The templates contain the proper format for creating the cost estimate, along with the WBS Titles.

CIVTMP - Civil Works Template
HTWTMP - HTRW Template
MILTM2 - Military Template - Normal WBS
MILEX1 - Military Template - Full WBS
MILEX2 - Military Template - Partial WBS

18.10.6 Work Breakdown Structure

The Work Breakdown Structure will be used as a guide in structuring the cost estimate and quantity survey sheets. The WBS should be reproduced and provided to each Cost Engineer working on the project. The WBS should be closely coordinated with the project Bid Schedule. If any problems arise in coordinating the Bid schedule and the WBS - the Mobile District Cost Engineering Branch should be contacted for resolution.

18.10.7 Training

MCACES GOLD training is available through Building System Design, Inc., Atlanta, GA (404-876-4700). This training is not mandatory; however, the Mobile District strongly feels it would be beneficial to all Cost Engineers involved in preparing MCACES GOLD cost estimates, especially first time MCACES users. All training costs must be borne by the designer.

18.10.8 Cost Estimate Submittal Checklist

The Checklist shall be filled in and used as the cover sheet for each cost estimate submittal. See Paragraph 18.3 above.

18.10.9 AF Form 1178 (Air Force Projects Only)

With each submittal of a cost estimate for an Air Force project, there shall be included an AF Form 1178, (See Paragraph 18.3 above) properly filled out with project information and in accordance with the instructions below:

(1) Blocks 1 through 59, excluding 14 and 46, are to be completed. If a block is not applicable, so state as N/A.

(2) Blocks 48 and 50 (Area Cost factor and Size Adjustment Factor) should be listed as N/A if actual area costs are used. If unit costs for common DOD facilities are used, the appropriate factors listed in the latest Tri-service report should be used.

(3) Compute Items 55 and 57 (Construction Contingency and SIOH) based on the appropriate percentage of Item 54f, Subtotal.

(4) Reference Block 52:

(a) The desired midpoint of construction (month/year) is to be calculated from Block 19, Construction Start, and Block 20, Months of Construction.

(b) The midpoint of available estimate (month/year) is the date the cost estimate is prepared.

(c) Both raw inflation indexes are to be obtained from the latest AF Cost Growth Factors via the Cost Engineering Branch Internet address.

(5) The SIOH in Block 57 is to 6.0%.

18.10.10 Unit Price Book Database

A hard copy of the Unit Price Book is not provided by the U.S. Army Corps of Engineers, Mobile District. However, if desired, it can be printed after downloading from the Internet and instructions obtained from the MCACES GOLD User Manual.

18.10.11 DD Form 1391

Military Construction Project Data, if available.

18.11 TECHNICAL INSTRUCTIONS FOR MCACES GOLD COST ESTIMATES

Note: The following instructions are based on a Military Project. Civil and HTRW would be similar.

18.11.1 Estimate Format

The Military Work Breakdown Structure (WBS) as provided by the Mobile district, and as specified above, shall be used on all Military Construction Projects (MCP). The Military WBS provides a common Tri-Service framework for preparing cost estimates, model development, and collecting historical data for all conventional MCP. This Military WBS is a hierarchical structure comprised of a total of eight levels: (0) Project, (1) Primary/Supporting/Additive Alternate/Option, (2) Facility (Bid Item), (3) System (WBS), (4) Subsystem, (5) Assembly Category, (6) Assembly, and followed by line item (7) Detail. Each system is divided into one or more subsystems which are further divided into assembly categories, then assemblies. Assemblies are made up of construction line items. The System, Subsystem and Assembly Category Titles are rigidly defined and shall not be changed. An Assembly is a collection of individual cost items that function together as a single building/construction unit. For example, a 12-inch storm drainage line consists of excavation, backfill, compaction, layer of drainage gravel, 12-inch concrete pipe, etc. One unit of an assembly contains a specified quantity and unit of measure of each included item. The Assembly has its own unit of measure. When the Assembly is “linked” and the assembly quantity is changed all included quantities are changed proportionately. Assemblies shall be created for building/construction systems as required by the project. In no case shall the WBS title descriptions be changed for levels (0) through (5). New titles for Subsystems or Assembly Categories shall be entered under the “Other” category. See the Military WBS. Note that the 01 through 15 Systems are for the interior of the building (5-foot line outside the building) and system 16 Selective Building Demolition fall under Primary Facilities. System 17 through 20 are exterior systems and fall under Support Facilities.

18.11.2 MCACES GOLD SOFTWARE AND DATABASES

ALL LABOR, CONSTRUCTION AND MATERIAL COSTS PROVIDED IN THESE DATABASES ARE A PRICING GUIDE ONLY. IT IS THE DESIGNER’S RESPONSIBILITY TO CHECK AND VERIFY PRICING USED IN HIS COST ESTIMATE. All Databases are compressed and can be loaded from within the MCACES GOLD software using

“LOAD FROM COMPRESSED” on the SERVICE Menu. All databases shall be loaded into the \GOLD\DATA\ directories. All databases provided are FOR OFFICIAL USE ONLY and shall be protected accordingly.

NOTE: LOAD FROM COMPRESSED - When using this command you are presented with a list of available databases to load for the Directory/Path you indicated. To select a database use the Up/Down Arrow keys to highlight the database you want to load and press the [Space Bar]. This will place a check mark to the left of the database. This can be repeated for any or all databases. After marking the databases you want loaded press the [Enter] key to start the process.

18.11.3 Military Estimate Hierarchy

When creating a MCACES GOLD cost estimate it is important to recognize that the construction project consists of the following hierarchical levels:

(1) NORMAL WORK BREAKDOWN STRUCTURE (WBS)

LEVEL 0 (Top Most Level)........PROJECT
LEVEL 1.........................SCOPE - PRIMARY/SUPPORT/ADDITIVE ALTERNATE/OPTION
LEVEL 2.........................BID ITEM - BOTH PRIMARY AND SUPPORTING FACILITIES
LEVEL 3.........................SYSTEMS (WBS)
LEVEL 4.........................SUBSYSTEM
LEVEL 5.........................OPTIONAL
LEVEL 6.........................OPTIONAL
LEVEL 7.........................OPTIONAL

NOTE: DETAIL CAN BE AT LEVEL 5, 6 OR 7.

(a) Project Level (LEVEL 0). All cost of the Primary and Support Facilities are accumulated to obtain a total project cost. This shall include all construction cost as well as Government-Furnished materials and items furnished through other than construction funds, ie information systems. Escalation, Construction Contingency and Supervision & Administration (S&A) or Supervision, Inspection & Overhead (SIOH) Costs are added at this level.

(b) Scope - Primary/Support/Additive Alternate/Options (LEVEL 1). Divides the project into Primary Facilities, Support Facilities, Category E Equipment and Government-Furnished Equipment based on DD Form 1391 format for the project. Additive Alternates or Options shall also be located at this level if required.

(c) Bid Items - Primary Facilities (LEVEL 2). Individual Facilities under Primary Facilities will be all individual building/major construction features. Individual Facilities under the Support Facilities shall be eight categories under Support Facilities of the DD Form 1391.

(d) System (LEVEL 3). Under Primary Facilities the interior Military WBS System 01 through 15 and System 16 are titled at this level. If there are multiple Primary Facilities, each one shall be broken down by the 01 through 16 Systems. Under Support Facilities the Military WBS Systems 17 through 20 are broken down under the appropriate eight categories defined by DD Form 1391.

(e) SubSystem (LEVEL 4). This level contains the Subsystem titles from the Military WBS for the above Systems. If there are subsystems in the project not identified by the Military WBS, they shall be identified using 90 through 99 under the appropriate System.

(f) Optional (LEVEL 5), (LEVEL 6) OR (LEVEL 7). These levels could be used to further define the project features. Detail can be at level 5, 6 or 7. Individual Cost Items are located at this lowest level in the cost estimate and reports at this level are referred to as Detail Reports. These are the basic work tasks consisting of labor, construction equipment and material cost and is the same level of detail as that found in the Unit Price Book Database. Some of the basic work tasks can be modified by “Modifiers” from the UPB.

(g) Modifiers are identified in the UPB Database and provide a method of adding or reducing, for optional quality or scope to the work task costs. Each modifier acts solely on the basic cost item it is assigned.

(2) FULL WORK BREAKDOWN STRUCTURE (WBS)

LEVEL 0 (Top Most Level)........PROJECT
LEVEL 1........................SCOPE - PRIMARY/SUPPORT/ADDITIVE ALTERNATE/OPTION
LEVEL 2........................BID ITEM - PRIMARY FACILITIES
LEVEL 3........................SYSTEM (WBS)
LEVEL 4........................SUBSYSTEM
LEVEL 5........................ASSEMBLY CATEGORIES, BID ITEM - SUPPORTING FACILITIES
LEVEL 6........................ASSEMBLY
LEVEL 7........................DETAIL

(a) Project Level (LEVEL 0). All cost of the Primary and Support Facilities are accumulated to obtain a total project cost. This shall include all construction cost as well as Government-Furnished materials and items furnished through other than construction funds, ie information systems. Escalation, Construction contingency and Supervision & Administration (S&A) or Supervision, Inspection & Overhead (SIOH) Costs are added at this level.

(b) Scope - Primary/Support/Additive Alternate/Options (LEVEL 1). Divides the project into Primary Facilities, Support Facilities, Category E Equipment and Government-Furnished Equipment based on DD Form 1391 format for the project. Additive Alternates or Options shall also be located at this level if required.

(c) Bid Items - Primary Facilities (LEVEL 2). Individual Facilities under Primary Facilities will be all individual building/major construction features. Individual Facilities under the Support Facilities shall be eight categories under Support Facilities of the DD Form 1391.

(d) System (LEVEL 3). Under Primary Facilities the interior Military WBS System 01 through 15 and System 16 are titled at this level. If there are multiple Primary Facilities, each one shall be broken down by the 01 through 16 Systems. Under Support Facilities the Military WBS Systems 17 through 20 are broken down under the appropriate eight categories defined by DD Form 1391.

(e) SubSystem (LEVEL 4). This level contains the Subsystem titles from the Military WBS for the above Systems. If there are subsystems in the project not identified by the Military WBS, they shall be identified using 90 through 99 under the appropriate System.

(f) Assembly Category, Bid Item - Supporting Facilities (LEVEL 5). This level contains the Assembly Category titles from the Military WBS for the Subsystems above. If there are Assembly Categories in the project not identified by the Military WBS, they shall be identified using 90 through 99 under the appropriate subsystem. In addition, this level contains the Bid Items for the Supporting Facilities.

(g) Assemblies (LEVEL 6). Assembly Titles shall be created at this level following the definitions contained in the WBS.

(h) Detail (LEVEL 7). Individual Cost Items are located at this lowest level in the cost estimate and reports at this level are referred to as Detail Reports. These are the basic work tasks consisting of labor, construction equipment and material cost and is the same level of detail as that found in the Unit Price Book Database. Some of the basic work tasks can be modified by “Modifiers” from the UPB.

(I) Modifiers are identified in the UPB Database and provide a method of adding or reducing, for optional quality or scope to the work task costs. Each modifier acts solely on the basic cost item it is assigned.

(3) <u>PARTIAL WORK BREAKDOWN STRUCTURE (WBS)</u>

LEVEL 0 (Top Most Level)........PROJECT
LEVEL 1.........................SCOPE - PRIMARY/SUPPORT/ADDITIVE ALTERNATE/OPTION
LEVEL 2.........................BID ITEM - BOTH PRIMARY AND SUPPORTING FACILITIES
LEVEL 3.........................SYSTEMS - CSI OR TRADES STRUCTURE
LEVEL 4.........................OPTIONAL
LEVEL 5.........................OPTIONAL
LEVEL 6.........................OPTIONAL
LEVEL 7.........................OPTIONAL

NOTE: DETAIL CAN BE AT LEVEL 4, 5, 6 OR 7.

(a) Project Level (LEVEL 0). All cost of the Primary and Support Facilities are accumulated to obtain a total project cost. This shall include all construction cost as well as Government-Furnished materials and items furnished through other than construction funds, ie information systems. Escalation, Construction contingency and Supervision & Administration (S&A) or Supervision, Inspection & Overhead (SIOH) Costs are added at this level.

(b) Scope - Primary/Support/Additive Alternate/Options (LEVEL 1). Divides the project into Primary Facilities, Support Facilities, Category E Equipment and Government-Furnished Equipment based on DD Form 1391 format for the project. Additive Alternates or Options shall also be located at this level if required.

(c) Bid Item - Both Primary & Supporting Facilities (LEVEL 2). Individual Facilities under Primary Facilities will be all individual building/major construction features. Individual Facilities under the Support Facilities shall be items such as: Exterior Electrical Distribution, Water Supply System, Sanitary Sewer System, Site Improvements, Parking Lot, Landscaping, etc.

(d) System (LEVEL 3). Under this title show the Construction Specification Index (CSI) items, such as: Concrete Moisture Protection, Finishes, Specialties, etc. or Trades, such as Asbestos removal, Plumbing, Insulation, Controls, Test & Balance, etc. or a combination of both. The major features of the project should be shown at this level.

(e) Optional (LEVEL 4), (LEVEL 5), (LEVEL 6) OR (LEVEL 7). These levels could be used to further define the project features. Detail can be at level 4, 5, 6 or 7.

18.11.4 <u>MCACES GOLD Common Errors</u>

A listing of common GOLD error messages, with explanations of the source of the error, are provided for your information in the MCACES GOLD User Manual.

18.11.5 <u>Quantity Take-Off</u>

The importance of accurate and concise quantity take-off to the cost estimate cannot be overstressed. The following procedures and exhibits must be followed in order for the designer to have an acceptable cost estimate. If a spot check of quantities by the District reveal inaccuracies or the required format has not been used in the preparation of the cost estimate, the estimate will be rejected and must be resubmitted with the deficiencies corrected. The quantity take-off is required to follow the applicable WBS.

The quantity take-off and cost estimate shall be treated in a confidential manner and only those personnel concerned with the preparation and/or review of the project shall have access to it. The cost estimate will be utilized in preparing government estimates for evaluating bids and shall be classified “FOR OFFICIAL USE ONLY”. Such material cannot be divulged to other than accredited Government personnel with a need to know.

Information contained within estimates shall not be divulged to prospective bidders. Parametric measurement(s) such as lump sums, building costs by square foot of area, etc. for all estimates are not permissible and estimates utilizing such will be rejected.

Prepare a quantity take-off in accordance with appropriate WBS showing all quantities used in the cost estimate. The estimator shall show all assumptions as to scope and design used in preparation of the cost estimate. These assumptions shall include WBS systems contained within the project. Proper allowances shall be made for WBS system and subsystems not completely determined in the plans, specifications and design analysis. The quantity take-off and cost estimate shall be an accurate representation of the complete design submitted. Quantity take-offs shall not be written on the drawings themselves. The quantity take-off shall be prepared in a manner that is clearly legible, indicating the calculations involved in determining the quantity and any assumptions the estimator has made in determining the quantity. The take-off shall contain backup and supporting sheets showing breakdown for all quantities of all materials contained within the design drawings and/or specifications.

The top of each quantity take-off sheet shall contain the following information: (1) project information; (2) the design stage; (3) the drawing file number and/or specification section & paragraph number from which the quantity was derived; (4) facility name, quantity, and Unit of Measure (UOM); (5) WBS code where the quantity is located in the cost estimate; and (6) the date and initials of the estimator who prepared them as well as the initials of the estimator who checked them. ALL QUANTITIES AND QUANTITY CALCULATIONS MUST BE CLEARLY TRACEABLE TO THE COST ESTIMATE ITEM THAT THEY SUPPORT.

18.11.6 Design Stage Identification

All sheets of the cost estimate and quantity take-off shall be clearly marked as to the design stage (concept, preliminary, final, etc.) the cost estimate represents. The design stage identity shall be entered in the “REPORT TITLE” field of the “PRINT SELECTED REPORTS” entry screen from the Report Menu of the MCACES GOLD software.

18.11.7 Wage Rates

If the project requires the designer to make changes to the Labor Database provided, the designer shall use the copy command from the “SERVICES” menu to copy the Labor Databases provided to a new Labor Database. The identification of the new Labor Database shall match the six-character code of the project ID. The new Labor Database shall be edited to reflect required changes to wage rates. If a new Labor Database is created, it shall be saved when saving the project database to compress.

18.11.8 Subcontractors

The list of subcontractors shown in the “MILTM2”,“MILEX1” or “MILEX2” template are for illustration only. The Mobile district acknowledges the fact that there can be more or fewer subcontractors than those indicated, depending on the size and/or type project being designed. There can also be several different subcontractors within a system, such as carpeting contractors and painting contractors within WBS System 06 - Interior Finishes. These subcontractors shall be broken out and defined in the Project Information Record within the MCACES GOLD cost estimate.

18.11.9 Prime Contractor Field Overhead

Itemized field overhead items for the Prime contractor shall be estimated in detail for all projects based on working knowledge of the project and the anticipated construction period. A generic itemized overhead (contained in the project template) will be provided by the Mobile District, Cost Engineering Branch as a starting place for the designer. The designer shall edit this itemized overhead to fit the specific project conditions. Items not applicable to this project shall be deleted and new items added as required.

18.11.10 Profit

The designer shall use the “Weighted Guideline Method” in determining profit for the prime contractor and major subcontractors

18.11.11 Major MCACES GOLD Menu Screens

The Major MCACES GOLD Menu Screens are shown in Exhibit 18-4. The “PROJECT DATABASE EDIT”, “NAME DATABASE COLUMNS”, “SET BREAKDOWN STRUCTURE”, “SELECT 2ND VIEW COLUMNS”, “EDIT DETAIL REPORT FORMATTING”, “EDIT OTHER REPORT FORMATTING”, “EDIT REPORT TITLE PAGE”, “PROJECT NOTES”, “SELECT REPORTS TO PRINT”, “PRINT SELECTED REPORTS”, “EDIT PERMISSION SETTINGS”, “EDIT BOND AND PROFIT TABLE”, “EDIT OWNER”, AND “PRIME CONTRACTOR OVERHEAD & PROFIT SCREEN” should be edited as shown and as appropriate.

18.11.12 Required Services

The designer shall supply the following Cost Engineering services:

(1) The overall project shall be analyzed by all disciplines involved in preparing the cost estimate to consider the following procedure before making the detailed quantity take-off. This shall be done before preparing the concept estimate as it will dictate the final estimate format needed in the preparation of the quantity take-off.

(2) Review the drawings and DD Form 1391 for the project to determine the number of Primary Facilities required in the project. Should the DD Form 1391 contain vertical buildings that can be identified by AR-415-28 Category Codes (no matter how small) in Support Facilities, the designer shall put these buildings under Primary Facilities in the estimate. When multiple buildings are involved make each building as a separate Facility under the Primary Facilities. (Example: Tactical Equipment Shop which has POL, Storage and Sentry Buildings). When multiple buildings are being constructed at different sites the designer shall prepare a separate facility for each building in the Primary Facility and separate Supporting Facilities for each building site. The designer shall prepare a proposed

Bidding schedule based on the Facility (LEVEL 2) of the Primary facility and the Support Facilities (LEVEL 5) for Site Work.

(3) When the number of buildings have been defined in the Primary Facility, each of the buildings shall follow the WBS of defined Systems, Subsystems, Assembly Categories, and Assemblies. The Site Work shall follow the DD Form 1391 and WBS format. The detail Quantity take-off shall follow this same format.

(4) When projects are funded by more than one funding source, all work related to each funding source shall be segregated respectively. Funding sources shall be identified separately at Level 1 in the MCACES estimate and shall be identified separately on the Proposed Bidding Schedule.

(5) If the cost estimate is to be prepared by more than one person on more than one computer and then merged into one Prime Estimate, follow the steps in Exhibit 18-5, MERGING MULTIPLE PROJECT DATABASES CHECKLIST. Failing to follow these steps may result may result in cost data having to be re-entered to correct the corrupted database. IT IS VERY IMPORTANT TO UNDERSTAND THAT THE MERGE AND EXTRACT ONLY WORK CORRECTLY WHEN THE FORMAT OF THE DATABASES ARE EXACTLY THE SAME.

18.12 STARTING THE MCACES GOLD PROJECT.

All program software and databases should be installed as described above. Activate the MCACES software following instructions from the MCACES GOLD User Manual. Before starting the project ensure that the appropriate Project Templates and Databases are selected in the Database Window. See Exhibit 18-6 “CREATE A NEW PROJECT CHECKLIST”.

(1) For Military WBS Projects the MILEX1 or MILEX@ Template shall be selected and shown in the Database Window. If it is not currently selected, use [F8] SELECT and highlight with the cursor and select. The Models, Assemblies, Unit Prices, Crews and Equipment Databases shall be selected in like manner. The Labor Database shall be the database for the project location. The below procedure is based on the MILEX1 template.

(a) With the proper project template selected and highlighted use “COPY A DATABASE” from the SERVICES menu and copy this database to a unique six-character identification code assigned by the designer. This will duplicate the information in MILEX1 or MILEX2 to your new project. Select the new project using [F8] SELECT. The new project ID shall now be in the DATABASE WINDOW.

(b) With the new project highlighted press [F4] EDIT and enter the official descriptive project title. Press [F10] to save.

(c) From the REPORTS menu choose Edit Report Title Page. Enter the appropriate information as shown on the screen. Use Project Notes [F7] to describe the overall general scope of the project. Present [F10] to save.

(2) Work on Project. Highlight the new project and press [Enter] to work on the project. The first item listed is the Project Information record. With the Project Information record highlighted press [F4] EDIT and enter the category code for the project from the DD Form 1391. Press [F4] to toggle out of EDIT and save the record.

(3) Prime Contractor. Choose to work on Project Information Records by highlighting the item and pressing [enter]. The Prime Contractor record is displayed. Edit the Prime contractor by pressing [F4] EDIT. The Field Overhead shall be set to “C” to calculate. Home Office shall be set to P (Percent), Profit set to “C” and Bond shall be set to “C”.

(a) OTHER Screen - The last line on the screen (the Status Line) indicates that an Other Screen is attached to this screen by the prompt “OTHER”. Choose the OTHER screen by pressing [Shift][F7] or using the [F9] MENU ADD/EDIT. This brings forward the attached Prime Contractor Window. The Profit Weighted Guideline Method of determining profit shall be used for the Prime contractor and all subcontractors. Each Risk factor field is HELP [F1] sensitive. By pressing [f1] HELP a description of the appropriate weight to apply to the project will be presented. Each Risk Factor shall be filled in based on the project cost, duration, complexity, and Contractor risks. Also see these instructions elsewhere.

(b) The Bond Class Field shall be set to “B”. This will cause the software to automatically calculate the Bond percentage used in the estimate. Press [F10] twice to save the information on the Prime Contractor. With the Prime Contractor Record highlighted press [Enter] to work on the Prime Contractor.

(c) Escalation, Construction Contingency and SIOH are entered on the “EDIT OWNER” entry screen located from the TITLE LEVEL where owner cost is set. Escalation Factors are found on the Cost Engineering Branch Internet homepage, and Construction Contingency & SIOH are shown in Exhibit 18-8.

(d) A list screen appears showing record 0 as the Itemized Overhead followed by a long list of typical subcontractors. Choose the Contractor’s Overhead by pressing [Enter] to get a list of typical Field Overhead for the Prime Contractor. This list is provided only as a guide. The designer shall add/delete items, edit quantities and adjust cost to represent a detailed itemized Field Overhead for this project. Pressing [F10] upon completion will save the data.

(4) Subcontractors. Now highlight the subcontractors and [F4] EDIT them. Any subcontractors not used in the estimate shall be deleted. In order for Contractors to be used in the estimate they must be assigned at the appropriate levek within the Primary/Support facilities. [F10] EXIT until you are back at the Project Information Record.

(5) Primary Facilities Title. Highlight the primary Facility Title and [f4] EDIT. On the Primary Facility Edit Screen the quantity shall be 1 LS (Lump Sum). Usually the Prime contractor ID “AA” is entered on this screen as he is usually the prime on all Facilities under Primary Facilities. The Contractor Override Field shall be set to “NO” and the

Project Category Code (from DD Form 1391) is typed into the Category Code Field.

(6) Facility Titles. Highlight the primary Facility and press [Enter] to the default FACILITY “Building One”. Create the number of Primary Facilities that has been determined. To create another Facility highlight FACILITY “Building One”. MARK this item by pressing [Shift][F9] or using the [F9] FUNCTION Menu - MARK. This places a check mark to the left of the title. Exit up a level [F10] and choose COPY from the FUNCTION Menu - MARK or press [Shift][F4]. This brings up a window allowing you to copy “AA.01 Building One” to a new location. Change the default AA.01 to AA.02 and press [Enter] to complete the copy. Now there are two identical Facilities under the Primary Facilities. Continue this process for all Primary Facilities in the project. After creating all of the Facilities, [F4] EDIT each FACILITY TITLE and type in the name of the Facility, and Gross Square Feet of the Building as the Facility Quantity and UOM. If the Prime Contractor was defined on the PRIMARY FACILITIES TITLE leave the Contractor Field blank. After editing the first facility pressing [PgDn] takes you to the next facility to edit.

(7) System Titles. With the FACILITY TITLE highlighted press [Enter] to go to Systems. The 01 to 15 System Titles and selective Demolition System 16 are predefined and the titles shall not be changed. Each title shall be edited to enter the appropriate quantity as defined in the WBS. Any SYSTEM TITLE not used in the project shall be deleted. Sometimes subcontractors can be identified at the Systems Title level as all work performed in the system is normally accomplished by one Contractor. For Example System 11 - Electric Power & Lighting is normally installed by the electrical Contractor “EL”.

(8) Subsystem Titles. With the SYSTEM TITLE highlighted press [Enter] to go to subsystems. The Subsystem Titles are predefined and the titles shall not be changed. Each title shall be edited to enter the appropriate quantity as defined in the WBS. When there are Subsystems in the project which are not defined in the WBS, the designer shall create them using 90 to 99 Identification Code. Any SUBSYSTEM TITLE not used in the project shall be deleted. Subcontractors can be identified at the Subsystem Title level if all work performed in the subsystem is normally accomplished by one Contractor.

(9) Assembly Category Titles. With the SUBSYSTEM TITLE highlighted press [Enter] to go to the Assembly Categories. The Assembly Category Titles are predefined and the titles shall not be changed. Each title shall be edited to enter the appropriate quantity as defined in the WBS. When there are Assembly categories in the project which are not defined in the WBS, the designer shall create them using 90 to 99 Identification Code. Any ASSEMBLY CATEGORY TITLE not used in this project shall be deleted. Sometimes subcontractors can not be identified at the Assembly Category title as all work performed in the category is normally not accomplished by one Contractor. For Example System 06 - Interior Finishes; Subsytem 01 - Wall Finishes; Assembly Category 03 - Gypsum Wallboard Finishes is normally installed by the “GW” Contractor and Assembly Category 04 - Tile & Terrazzo Wall Finishes is normally installed by the “TE” Contractor.

(a) When Assemblies can be used multiple times within the project it is beneficial to the estimator to create the Assembly in the MODEL's DATABASE rather than in the project. Assemblies from the MODEL's DATABASE can be copied into the project as often as required. The designer shall copy the Generic Models Database using Copy A Database from the SERVICES Menu to the same six characters as was used to name the project. Select this new Model's Database and use it to create new assemblies. This new Model's Database shall be submitted along with the project and labor rates database with each submittal.

(10) Assembly Titles. The project template contains no Assembly Titles. The designer shall create the Assembly Titles based on the requirements of the project. The WBS provides a description of detailed items found in the assemblies.

(a) CREATE an ASSEMBLY TITLE. Highlight the appropriate ASSEMBLY CATEGORY and from the FUNCTION MENU "ADD/EDIT" choose "Add Subtitle" or press [Shift][F3]. This will put you in the Add Subtitle Mode where you must enter a two character Assembly ID. This ID will normally be 01-99 but alpha characters may be used if required. You are now ready to look for an existing assembly or create a new assembly.

(b) LOOKUP an ASSEMBLY. Press [F6] LOOKUP and choose "Models" to look into the Models Database for available Assemblies that may exist. If an appropriate Assembly is located in the Models Database, it can be copied into the project by highlighting the Assembly Title and pressing [F6] LOOKUP. You will be prompted to "Confirm Lookup" and by pressing [Enter] will accept what was looked up. You will then be prompted to "OMIT Detail (Y/N)? N." with No being the default. Press [Enter] to receive detail. With Lookup completed you will have the Assembly title and detail items making up the Assembly in your project. Press [F10] to exit Add and press [Enter] to select the Assembly and view the Detail List screen. If the detail items have the letter "P" to the left of the quantity in the Quantity Field, the detail items have been linked to the "Parent Quantity", the Assembly Title in this case. You will not be able to edit the Assembly Title and enter the correct assembly quantity which will then adjust the detail quantities.

Note: Some of the assemblies are not linked and the assembly quantity will not adjust the detail. This is the case when there is not a direct correlation between assembly quantity and detail quantity. When this is the case there will not be a "P" in the detail quantity field and the detail quantity has to be entered at detail. Each Detail quantity will require editing.

(c) CREATING an ASSEMBLY. If there is not an assembly already created that reflects the assembly needed for the project, then the designer shall create the assembly from detail items in the Unit Price Database. Locate the correct ASSEMBLY CATEGORY TITLE and Add Subtitle [Shift][F3]. This puts you in the Assembly Add Screen where you enter the Assembly ID, Title, Quantity and Assembly UOM. Reference WBS for UOM's. Press [f10] to save. Choose to work on the newly created Assembly Title by pressing [Shift][F5] ADD DETAIL. On the Cost Item Entry Screen the first two fields of the "Project Sequence/Database" ID requires no entry. Position the cursor to the third and press [F6] LOOKUP and choose to lookup into the Unit price Database [Shift][F6]. The software will place you at the top of the Unit Price Database. After selecting or marking the detail items needed in the assembly press [F6] and then confirm lookup. This will return all detailed items marked to your project. Press [F10] to exit Add Detail and save the items. Now check that all detail quantities are correct foor your project by editing each item or, if appropriate, you can link the detail items to the Assembly quantity. Paragraph 18.12.(10) shall be repeated for all Facilities under Primary Facilities.

Note: One must be located at DETAIL in the UPB when copying multiple detail items into the project, e.g. pressing [F6] to complete lookup. If [F6] is pressed while located at a title level, only the last marked item will be copied into the project.

(11) Support Facilities Title. in most projects there is only one set of Support Facilities (all primary Facilities are constructed on the same site). When there is only one set of Support Facilities this title record needs only to be edited to identify the Prime Contractor.

(12) Adding Additional Support Facilities. Occasionally there are projects that contain multiple Primary Facilities on more than one site. When this happens the Support Facilities Titles shall be duplicated by using [F2] ADD to create a second Support Facilities Title. Exit to save the title. Arrow to the original Support Facilities and press [Enter] to reach Facility level. Use the [shift][F9] to mark each Facility Title, [F10] up a level and arrow to the New Support Facilities Title. Now use [Shift] [F4] COPY to copy the facility titles. The second Support Facilities Title description shall be edited and the Prime Contractor shall be identified. This shall be repeated for each separate site location.

18.13 PRINT SELECTED REPORTS

The following procedures shall be required by the designer when creating the required printed reports for all submittals. See Exhibit 18-7 “PRINT SUBMITTAL REPORTS CHECKLIST”.

(1) PACK A DATABASE. When making an estimate submittal to the Mobile District, the Project Database shall be packed to permanently erase deleted records from the project. From the SERVICES Menu choose Pack A Database while the project is highlighted in the Database Window.

(2) SELECT REQUIRED REPORTS. The Mobile District Required Report settings shall be selected before executing the print command. From the REPORTS Menu choose Save/Load Report Settings. The first prompt asks if you want to Save Current Settings and the correct response is “N” for no. The second prompt asks if you want to Load Different Report Settings and the correct response is “Y” for yes. The Keyword Search Window now prompts for a Match ID. Type in the word SUBMITTAL and press [Enter] twice to activate the search. “SUBMITTAL Mobile District Required Reports” will be one of the choices presented. Select this choice by highlighting the cursor and pressing [Enter]. This will load the required reports settings.

(3) Printer Setup. The printer shall be set up to print in Landscape Mode with 172 characters per line and 66 lines per page.

(4) Activate Reports Generator. From the REPORTS Menu choose Print Selected Reports. Type in the estimate design status (Conceptual, Final, etc.) in the Report Title Field.

(a) Send Reports to Printer. When sending the Reports directly to the printer as they are created enter PRN in the Printer device Field and press [OgDn] to activate writing the reports.

(b) Send Reports to File. If you want to send the Reports to a file and print at a later time or view the reports before printing, type in a filename.txt in the Printer Device Field and press [PgDn]. This writes the report to the file and the file can be printed later using the DOS Print command.

(c) Viewing a Reports File. If the reports were written to a file, the file may be viewed using View Reports with Viewer from the REPORTS Menu.

18.14 SAVE TO COMPRESSED

After generating and printing the required submittal reports the database shall be “SAVED TO COMPRESSED” to diskette.

(1) Compress Project Database. The project database shall always be SAVED TO COMPRESSED. A formatted diskette is required to complete the process. Highlight the project in the Database Window. From the SERVICES Menu choose SAVE TO COMPRESSED and enter the Project ID. When prompted to “Save Related Databases along with Project?” respond “N” for No. When the compression process is complete, save to the diskette.

(2) Compress Assembly and/or Models Databases. If new items were created in the Models or Assembly Databases, those databases shall be Saved to Compressed along with the project. To Save to Compressed the Assembly or Models Database highlight either and use Save to Compressed. When prompted with the path of the databases press [Enter] and a list of available databases will be presented. Use the Up/Down arrow to locate the database(s) you want to compress and press the [Space Bar] to put a “Check Mark” by that database. When all databases have been marked press [Enter] to start the compression process. With the compression process complete save to diskette. The compressed Project is displayed with a check mark to the left of the ID in the “Keep Database Window”. Press [Enter] to keep the project and also save the compressed Assembly or Models to the same diskette. The next prompt will be “Diskette is NOT BLANK, Delete ALL Non-Database Files?”. Respond “Y” for yes. This will save both the project and other databases to, compressed diskette.

(3) Compress Labor Database. Labor rates shall be saved to compress along with the project.

(4) Diskette Labels. The following information shall be recorded on all diskettes submitted to the Mobile District:

Project Title:
Location:
Project Identification Code (6 Character Code)
Design Status, e.g. “(95% Cost Estimate Submittal”
Load from Compressed 1 of ?

FIELD INDIRECT COSTS

1. Supervisory and Administrative Personnel

   Field Project Manager
   General Superintendent
   Assistant Superintendents
   Construction Trade Superintendents
   Equipment Superintendent

2. Engineering Personnel

   Project Engineer
   Office Engineer
   Quality Control Engineers
   Surveyor and Surveymen
   Draftsmen

3. Office Staff

   Office Manager
   Payroll Clerk
   Clerk-Typists
   Purchasing Agent
   Janitor

4. Miscellaneous Staff

   Safety Engineer, Nurse, First-Aid Attendant
   Warehousemen
   Clerks
   Security Personnel

5. Job Expenses

   Office Facilities
   Shops, Warehouses, and Yards
   Laboratory and Testing Expense and Facilities
   Night Lighting Work Area
   Construction and Maintenance of Access and Haul Roads
   Office and Engineering Supplies and Equipment
   Water, Power, Telephone, Radios, Sanitary Facilities
   Project Sign and Bulletin Board
   Vehicles and Transportation Expenses
   Travel, Subsistence, Housing, etc. for Key Personnel
   Permits, Easements and Rights-of-Way
   Builder's Risk Insurance
   Environmental Protection, Dust Control, and Restoration
   Progress Schedules and Reports
   Job Cleanup

WEIGHTED GUIDELINES METHOD FOR DERIVATION OF PROFIT FACTOR

PROCEDURES:

Based on specific project circumstances and considering the explanation of weights below, select appropriate weight values from the following table. For M-CACES GOLD estimates, enter the weights via Contractors' Overhead and Profit Entry Screens and the system will calculate profit. For manual estimates, multiply rates by weights. Add resulting values and round to the nearest tenth to obtain profit factor.

FACTOR	RATE		WEIGHT(.03-.12)		VALUE
Degree of Risk	20	x	______	=	_____
Relative Difficulty of Work	15	x	______	=	_____
Size of Job	15	x	______	=	_____
Period of Performance	15	x	______	=	_____
Contractor's Investment	5	x	______	=	_____
Assistance by Government	5	x	______	=	_____
Subcontracting	25	x	______	=	_____
			TOTAL	=	_____

EXPLANATION OF WEIGHTS:

Degree of Risk. Weight within range of .03 for slight risk to .12 for highest risk. Consider lump sum items riskier than unit price items. Also, consider nature and location of work, amount subcontracted, ratio of labor to total cost and whether work has already been accomplished.

Relative Difficulty. Weight within range of .12 for most difficult and complex to .03 for simplest work.

Size of Job. Select appropriate weight below.

Size of Job		Factor	Size of Job		Factor
$ 0	$100,000	0.120	600,000	700,000	0.083
100,000	200,000	0.119	700,000	800,000	0.081
200,000	300,000	0.117	800,000	900,000	0.080
300,000	400,000	0.116	900,000	3,000,000	0.079
400,000	500,000	0.114	3,000,000	100,000	0.077
500,000	600,000	0.113	100,000	200,000	0.076
600,000	700,000	0.111	200,000	300,000	0.074
700,000	800.000	0.110	300,000	400,000	0.073
800,000	900,000	0.109	400,000	500,000	0.071
900,000	1,000,000	0.107	500,000	600,000	0.070
1,000,000	100,000	0.106	600,000	700,000	0.069
100,000	200,000	0.104	700,000	800,000	0.067
200,000	300,000	0.103	800,000	900,000	0.066

Size of Job		Factor	Size of Job		Factor
300,000	400,000	0.101	900,000	4,000,000	0.064
400,000	500,000	0.100	4,000,000	100,000	0.063
500,000	600,000	0.099	100,000	200,000	0.061
600,000	700,000	0.097	200,000	300,000	0.060
700,000	800,000	0.096	300,000	400,000	0.059
800,000	900,000	0.094	400,000	500,000	0.057
900,000	2,000,000	0.093	500,000	600,000	0.056
2,000,000	100,000	0.091	600,000	700,000	0.054
100,000	200,000	0.090	700,000	800,000	0.053
200,000	300,000	0.089	800,000	900,000	0.051
300,000	400,000	0.087	900,000	5,000,000	0.050
400,000	500,000	0.086	5,000,000	10,000,000	0.040
500,000	600,000	0.084	OVER	10,000,000	0.030

Period of Performance. Select appropriate weight below.

	Factor		Factor
OVER 24 MONTHS	0.120	12 TO 13 MONTHS	0.075
23 TO 24 MONTHS	0.116	11 TO 12 MONTHS	0.071
22 TO 23 MONTHS	0.112	10 TO 11 MONTHS	0.068
21 TO 22 MONTHS	0.109	9 TO 10 MONTHS	0.064
20 TO 21 MONTHS	0.105	8 TO 9 MONTHS	0.060
19 TO 20 MONTHS	0.101	7 TO 8 MONTHS	0.056
18 TO 19 MONTHS	0.098	6 TO 7 MONTHS	0.052
17 TO 18 MONTHS	0.094	5 TO 6 MONTHS	0.049
16 TO 17 MONTHS	0.090	4 TO 5 MONTHS	0.045
15 TO 16 MONTHS	0.086	3 TO 4 MONTHS	0.041
14 TO 15 MONTHS	0.082	2 TO 3 MONTHS	0.037
13 TO 14 MONTHS	0.079	1 TO 2 MONTHS	0.034
		UNDER 30 DAYS	0.030

Note: Weight @ 0.0 if change order work not requiring time extension.

Contractor's Investment. Weight from .03 to .12 for below average to above average. Consider amount subcontracted, frequency of progress payments, whether there is pay item for mobilization, etc.

Assistance by Government. Weight from .12 to .03 for average to above average. Consider use of Government facilities, expediting assistance, etc.

Subcontracting. Select weight below, based on % of work subcontracted.

		Factor
SUB -	80% OR MORE	0.030
	70% TO 80%	0.042
	60% TO 70%	0.055
	50% TO 60%	0.068
	40% TO 50%	0.080

30% TO 40%	0.092
20% TO 30%	0.105
10% TO 20%	0.118
0% -- --	0.120

EXHIBIT 18-2
2 OF 2

TECHNICAL QUALITY CONTROL CHECKLIST

This checklist should serve as a tool to ensure that all areas of the cost estimate are properly prepared and adequately reviewed.

GENERAL

[ ] Has the reviewer been provided:

- [ ] A complete detailed cost estimate?
- [ ] All supporting backup?
- [ ] All applicable design documents (plans, specifications, design analysis, etc.)?
- [ ] Annotated Comments?

[ ] Has cost estimate been approved by the Chief, Cost Engineering Branch?

[ ] Does the reviewer have a clear Definition of Scope?

[ ] Has the estimator(s) visited the project site?

[ ] Is the Sign-thru Cover Sheet for the Government Estimate that discloses the overall project cost estimate stamped “FOR OFFICIAL USE ONLY”?

[ ] Has the Project Manager been notified of the estimated price verses the available funds?

CONTRACT REQUIREMENTS (A-E/COST CONSULTANT ONLY)

[ ] Has the Cost Estimate Submittal Checklist been provided?

[ ] Has the Cost Estimate been submitted in the required number of copies, suitably-bound, in landscape?

[ ] Was AF Form 1178 provided (AF Projects Only)?

[ ] Were the specified diskette(s) provided?

[ ] Was all cost estimate supporting data provided?

BID SCHEDULE

[ ] Does the Bidding Schedule contain Bid items for the following work features, if applicable?

- [ ] Each Building to the 5 ft line?
- [ ] Major site features (e.g. Sanitary Sewer System, Exterior Electrical Distribution, Parking Lot, etc.)?
- [ ] Design Costs?
- [ ] Asbestos Abatement?
- [ ] Unit Cost Items (e.g. Rock Excavation, Unclassified Excavation, etc.)?
- [ ] Pre-Wired Work Stations?
- [ ] Project Manager/Customer Requested Items?
- [ ] Separately Funded Items (e.g. OMAR Equipment, etc.)?
- [ ] Additive Alternates?
- [ ] Options?

FORMAT

[ ] Has all required summaries been furnished?

[ ] Has the required detail been furnished?

[ ] Has the correct software been used?

[ ] Were the correct Databases used in preparing the cost estimate?

[ ] Has the MCACES Backup Reports for Wage rates and Construction Equipment been furnished?

[ ] Were the MCACES Project and Contractor Settings furnished?

[ ] Has all MCACES errors been cleared?

[ ] Is the cost estimate in the required Work Breakdown Structure (WBS) to Level 4 (Subsystem)?

[ ] Is the cost estimate structured according to the type contractor most likely to bid as prime?

[ ] Has a sufficient number of subcontractors been developed for the project?

[ ] Is a majority of the work selected to be done by the prime contractor or subcontractor(s) according to normal construction practice?

[ ] Does the cost estimate include escalation, construction contingency and SIOH?

[ ] Is the cost estimate so structured to be directly comparable to the project Bid Schedule?

[ ] Is the Scope-Of-Work adequately defined in the Project Notes?

[ ] Can the cost estimate be compared to the "1391"?

[ ] Is the cost estimate within the Construction Cost Limitation (CCL)?

[ ] If the cost estimate is more than the CCL, have Additive Alternates or Options been identified that bring the Base Bid within the CCL?

[ ] Have all amendments been acknowledged in the cost estimate?

[ ] Has the cost estimate been compared to the previous cost estimate?

[ ] If the cost estimate has changed more than 5% (+ or -) from the previous cost estimate, has reasons why been documented?

[ ] Have all "assumptions" been documented in the cost estimate?

[ ] Are all detail tasks in the cost estimate sufficiently described?

[ ] Have specialty construction tasks (e.g. scaffolding, noise & dust control, phasing, etc.) been included in the cost estimate?

[ ] Are "Units of Measure" proper?

MAGNITUDE OF DETAIL

[ ] Is the Level of detail commensurate with detail available from the design documents?

[ ] Does the cost estimate include all design amendments?

[ ] Have MCACES task overrides been sufficiently utilized?

[ ] Does the cost estimate contain any unsupported lump sums?

BACKUP

[ ] Has all Backup (Quantity Takeoff, Quantity Derivations and Quotations) been furnished?

[ ] Is all Backup traceable to the line item task in the cost estimate that it supports?

[ ] Is Backup clear and understandable?

[ ] Was sufficient quotations furnished?

[ ] Was Backup current?

[ ] Do quantities appear to be reasonable?

[ ] Is Quantity Takeoff sufficient?

[ ] Are Quantity Derivations clear and properly prepared?

[ ] Did the reviewer spot check critical cost items and quantities?

DIRECT COSTS - MATERIAL

[ ] Are all major material items supported by a current quotation?

[ ] Does quotation used include all applicable costs (e.g. manufacturer/supplier, location, person contacted, telephone number, date, freight to job site, etc.)?

[ ] Is Sales Tax in the cost estimate?

[ ] Is Sales tax shown correctly for project area?

DIRECT COST - LABOR

[ ] Have the wage rates been compared to the Davis-Bacon minimum wage rates?

[ ] Does the wage rates reflect the local prevailing wage rates?

[ ] Does the total wage rate shown include basic wage rate, fringes, OT, payroll taxes & insurance, etc.?

[ ] Do the labor productivities used consider project conditions, labor availability, market conditions, etc.?

DIRECT COST - CONSTRUCTION EQUIPMENT

[ ] Has Construction Equipment Cost for major items been included in the cost estimate?

[ ] Has small tools cost been included in the cost estimate?

[ ] Has any construction equipment been included using "rental" rates?

SUBCONTRACTED WORK

[ ] Has subcontractor work been included in the cost estimate?

[ ] Is all major subcontractor work detailed? *Note: Minor work maybe* unit priced.

[ ] Does the project contain any work that is normally done by a 2nd Tier Subcontractor Work (e.g. Controls, Test & Balance, Insulation, etc.)?

[ ] Were subcontractor quotes obtained to verify the reasonableness of the of the estimate for the subcontractor work?

[ ] Were subcontractor markups reasonable?

PRIME CONTRACTOR OVERHEAD

[ ] Is all Prime Contractor Field Overhead detailed?

[ ] Has the Prime Contractor Field overhead been prorated to all Bid Items proportionally to the direct costs?

[ ] Have those items in the specification "Special Clauses" that are normally considered "Field Overhead Items" been incorporated into the cost estimate?

[ ] Is the Prime Contractor Field Overhead reasonable?

[ ] Has Mobilization/Demobilization costs been included in the cost estimate?

[ ] Do overhead salaries shown include an allowance for payroll taxes & insurance?

[ ] Are all overhead fixed costs included in the Base bid?

[ ] Is Prime Contractor Home Office Expense included in the cost estimate?

[ ] Is the Prime Contractor Home Office Expense reasonable?

PROFIT

[ ] Was Prime Contractor Profit included in the cost estimate?

[ ] Was Profit for the Prime Contractor determined using the "Weighted Guideline Method"?

[ ] Were the fixed cost (Size of Job, Period of Performance, Amount of Subcontracting) portion of the "Weighted Guideline Method" done correctly?

[ ] Were the judgmental factors (Degree of risk, Relative Difficulty of Work, Contractor's Investment, Assistance by Government) reasonable?

BONDS

[ ] Has Bond been included on the entire contract amount?

[ ] Has Bond cost been calculated?

[ ] Is Bond cost reasonable?

COST ESCALATION

[ ] Was Cost Escalation included in the cost estimate?

[ ] Were all construction costs escalated to the "Midpoint of Construction? *Note: Army - Escalate from Midpoint of Estimate to Midpoint of Construction, AF - Escalate from Date of Submittal to Midpoint of Construction.*

[ ] Have "indices" and "dates" been shown?

CONSTRUCTION CONTINGENCY

[ ] Was a Construction Contingency percentage shown in the cost estimate?

[ ] Is the percentage correct?

SUPERVISION & ADMINISTRATION COST

[ ] Was a SIOH or S&A percentage shown in the cost estimate?

[ ] Is the percentage correct?

MODIFICATIONS

[ ] Has field office/cost estimator discussion been held?

[ ] Has adequate information been received to reflect actual contractor rates?

[ ] Has the original scope and changed scope been clearly defined?

[ ] Is the net change in scope presented clearly?

[ ] Does the estimate include costs and time for the impact on the unchanged work?

[ ] Were current, actual labor rates utilized?

[ ] Is backup and support for the estimate pricing available?

DREDGING

[ ] Was CEDEP used to prepare the cost estimate?

[ ] Does the narrative document the decisions and selections made within CEDEP?

[ ] Has effective working time been calculated considering lost time, weather delays, etc.?

[ ] Have estimate results been compared against historic information and reconciled if necessary?

[ ] Has the estimate been compared against data from similar projects?

[ ] Have production rates been calculated considering pumping rate, travel time, line size, navigational delays, etc.?

[ ] Have environmental requirements (beach and offshore) been included?

[ ] Does the estimate reflect correct environmental windows for the project area?

EXHIBIT 18-3
8 OF 8

M-CACES GOLD
MAJOR MENU SCREENS

PROJECT DATABASE EDIT

	PROJECT Database Edit
	Database ID : *(6 Characters)*
FUNCTION	
HELP	Name : *(32 Characters)*
ADD	
TITLES	LAST REPRICE REFERENCES Unit Price Database : *(6 Characters)*
EDIT	Crew Database : *(6 Characters)*
DETAIL	Labor Database : *(6 Characters)*
LOOKUP	Equipment Database : *(6 Characters)*
NOTES	COMPUTATION Measurement System : Original
SELECT	CURRENCY Currency Symbol : $
MENU	Currency Description : Dollars
EXIT	Units for Store/Display : O-Ones
	Units per U.S. Dollar : 1.0000

Note: The (Database ID) will show up on the 2nd line of the title on every page of the cost estimate.
The (Name) will show up on the 1st line [Project : (Name - Proj Database Edit Screen)] on the REPORT TITLE PAGE.

EXHIBIT 18-4
1 OF 9

NAME DATABASE COLUMNS

PREPARE

	PROJECT COLUMNS
	Estimate Type : A-Crews with Auto Reprice
FUNCTION	
HELP	**PROJECT DIRECT COST COLUMNS**
ADD	Col Type **H L E M X**
TITLES	Rep Width **8 10 10 10 0**
EDIT	Title **MANHOURS LABOR EQUIPMENT MATERIAL (Unused)**
DETAIL	**PROJECT INDIRECT COST COLUMNS**
LOOKUP	Col Type **O U P B X**
NOTES	Rep Width **12 12 12 12 0**
SELECT	Title **FIELD OH HOME OFC PROFIT BOND (Unused)**
MENU	**PROJECT OWNER COST COLUMNS**
EXIT	Col Type **E C U X X**
	Rep Width **12 12 12 0 0**
	Title **ESCALATN CONTGENCY SIOH (Unused) (Unused)**

SET BREAKDOWN STRUCTURE

PREPARE

	PROJECT BREAKDOWN
	Trail Level 2nd View
FUNCTION	ID Length Sep Title Order
HELP	
ADD	Level 1 ID 2 . Scope 0
TITLES	Level 2 ID 2 . Bid Item 0
EDIT	Level 3 ID 2 . System 0
DETAIL	Level 4 ID 2 . Subsystem 0
LOOKUP	Level 5 ID 2 . Assm Cat 0
NOTES	Level 6 ID 2 . Assembly 0
SELECT	
MENU	
EXIT	Owner Cost Level : 0

EXHIBIT 18-4

SELECT 2ND VIEW COLUMNS

PREPARE

	SELECT 2ND VIEW COLUMNS
	Quantity Column Width : 10
FUNCTION	
HELP	
ADD	Col Type **D** **C** **P** **X** **X**
TITLES	Rep Width **12** **12** **12** **0** **0**
EDIT	Title **DIRECT** **CONTRACT** **PROJECT** **(Unused)** **(Unused)**
DETAIL	
LOOKUP	Shadow **x** **x** **x** **x** **x**
NOTES	
SELECT	
MENU	
EXIT	

EDIT DETAIL REPORT FORMATTING

REPORTS

	DETAIL REPORT FORMATTING	
	PAGE OPTIONS	Page Break Levels : 2
		Table of Contents Levels : 3
FUNCTION		0 1 2 3 4 5 6 7
HELP	ROW OPTIONS	Print Titles at Levels : Y Y Y Y Y Y
ADD		Print Totals at Levels : Y Y Y N N N
TITLES		Print Notes at Levels : Y Y Y Y Y Y Y Y
EDIT		Print Unit Cost Row : Y
DETAIL		Print Page Footer : Y
LOOKUP		Show Cost Codes : Y
NOTES	COLUMN OPTIONS	Print Crew ID : Y
SELECT		Crew Output : Y
MENU		Unit Cost : Y
EXIT	UPB TITLES	No. of Levels to Print : 0
		Bracket Titles With : N N
		Include Title Notes : N

EXHIBIT 18-4

EDIT OTHER REPORT FORMATTING

REPORTS

	OTHER REPORT FORMATTING
	COLUMN TITLES FOR SUMMARY REPORTS
	Column 1 OVERHEAD : Contractor's Field Overhead
FUNCTION	Column 2 HOME OFC : Contractor's Home Office
HELP	Column 3 PROFIT : Contractor's Profit
ADD	Column 4 BOND : Contractor's Bond
TITLES	Column 5 (Unused) : (Unused)
EDIT	Column 1 ESCALATN : Escalation
DETAIL	Column 2 CONTGENY : Construction Contingency
LOOKUP	Column 3 SIOH : Supervision, Inspection and Overhead
NOTES	Column 4 (Unused) : (Unused)
SELECT	Column 5 (Unused) : (Unused)
MENU	STANDARD COLUMN WIDTHS SUMMARY FEATURES
EXIT	Quantity Columns : 10 Round Summary Costs : N-None
	Total Cost Columns : 12 Contingency Notes : No
	Unit Cost Columns : 10 Show Project Totals : Yes

EDIT REPORT TITLE PAGE

REPORTS

	REPORT TITLE PAGE
	Project : *(Name - Proj Database Edit Screen)*
	(Location)
FUNCTION	*(% Design Status)*
HELP	*(Solicitation No. & Bid Opening Date)*
ADD	*(Amendment Acknowledgement)*
TITLES	Designed By : *(Architect-Engineer Company Name)*
EDIT	Estimated By : *(Cost Consultant Company Name)*
DETAIL	Prepared By : *(Names of Estimator(s))*
LOOKUP	
NOTES	Date of Escalation Index : *(See Cost Engr Br Internet Homepage)*
SELECT	Effective Pricing Date : *(Construction time plus 2 months)*
MENU	
EXIT	Preparation Date : *(Automatic)*
	Est Construction Time : _____ Days *(Calendar Days)*
	Sales Tax : *(See Cost Engr. Branch Internet Homepage)*

EXHIBIT 18-4

PROJECT NOTES

REPORTS

	PROJECT NOTES
	(Scope-of-Work of the Project)
FUNCTION	*Note: At the RTA Stage, the Scope-of-Work should be obtained from Section*
HELP	*00100 of the Specifications*
ADD	
TITLES	
EDIT	
DETAIL	
LOOKUP	
NOTES	
SELECT	
MENU	
EXIT	

SELECT REPORTS TO PRINT

REPORTS

	REPORT SELECTION (PgDn to Print Selected Reports)
	Project Settings : **Y** Profit Guidelines : **Y**
	Contractor Settings : **Y**
FUNCTION	Link Listing : **N** Measurement Units : **Original**
HELP	REPORT FORMAT TYPE FOR LEVEL(S)
ADD	Direct Indirect Owner 0 1 2 3 4 5 6
TITLES	Detail : **Y**
EDIT	Project : **Y** **Y** **Y** **Y Y Y N N N**
DETAIL	Contractor : **N** **Y** **N** **N N N N N N**
LOOKUP	Division : **N** **N** **N** **N N N N N N**
NOTES	System : **N** **N** **N** **N N N N N N**
SELECT	2nd View : **N**
MENU	Crew : **N** **Y N N N N N**
EXIT	Labor : **Y**
	Equipment : **Y**
	Prime Labor Cost Level : **2**

EXHIBIT 18-4

PRINT SELECTED REPORTS

REPORTS

FUNCTION	
HELP	
ADD	Report Title : *(48 Characters)* *(% Design Status or Sol No w/Amend* Print Device : *(48 Characters)* Printer Setup : *(26 Characters)*
TITLES	
EDIT	
DETAIL	
LOOKUP	
NOTES	
SELECT	
MENU	
EXIT	

Note: The Report Title will show up on the 3rd line of the title on every page of the cost estimate.

EDIT PERMISSION SETTINGS

ADMIN

	ADMINISTRATOR SETTINGS
	DATABASE EDIT-ACCESS Models Database : No
	Assemblies Database : No
FUNCTION	Unit Price Database : No
HELP	Crews Database : No
ADD	Labor Rates Database : Yes
TITLES	Equipment Rates Database : No
EDIT	PROJECT PERMISSIONS Project Structure Access : No
DETAIL	Allow Cost Overrides : Yes
LOOKUP	Allow Report Format Edit : No
NOTES	AUXILIARY PROGRAMS
SELECT	User's File Viewer : **C:\GOLD\CG_VIEWR.COM**
MENU	Communications :
EXIT	
	DIGITIZER SELECTION : A-None

EXHIBIT 18-4

EDIT BOND AND PROFIT TABLES

ADMIN

	BOND AND PROFIT TABLES				
	BOND COMPUTATION	Range	Cls B	Cls A	Cls A-1
	0 to :	100,000	**2.500%**	**1.500%**	**0.940%**
FUNCTION	100,000 to :	500,000	**1.500%**	**1.000%**	**0.720%**
HELP	500,000 to :	2,500,000	**1.000%**	**0.700%**	**0.500%**
ADD	2,500,000 to :	5,000,000	**0.750%**	**0.550%**	**0.450%**
TITLES	5,000,000 to :	7,500,000	**0.700%**	**0.500%**	**0.450%**
EDIT	7,500,000 to :	Maximum	**0.600%**	**0.450%**	**0.400%**
DETAIL	Additional per month over 12 :		**1.000%**		
LOOKUP	PROFIT WEIGHTING FACTORS		Risk	20%	
NOTES			Diff	15%	
SELECT			Size	15%	
MENU			Period	15%	
EXIT			Invest	5%	
			Assist	5%	
			Subcon	25%	

EXHIBIT 18-4
7 OF 9

EDIT OWNER

FUNCTION
HELP
ADD
TITLES
EDIT
DETAIL
LOOKUP
NOTES
SELECT
MENU
EXIT

	ESCALATN	CONTINGN	SIOH
	0	**0**	**0**
	0.00%	**0.00%**	**0.00%**
	0.00	**0.00**	**0.00**

Escalation Start Date/Index : **00/00** **0.000**
Escalation End Date/Index : **00/00** **0.000**
Contingency Note(s) No. :

This function is used to add or change Owner Cost information for a Project Database. The Edit Owner option is only available from title entry screens at the lowest title level and at the default Owner Cost Level designated on the Set Breakdown Structure Screen.

Cost Method:

This code specifies the method of figuring the indicated Owner Cost. Valid codes are:

0 - Set at Owner Level. Automatically entered by the program if the Owner Cost is set at a higher title level.

P - GOLD calculates the cost by multiplying the percentage entered in the field below times the running total. The running total is the total of field below times the running total. The running total is the total of Project Direct and Indirect Costs plus the Owner Costs in any columns to the left of the present column.

D - GOLD calculates the cost by multiplying the percentage entered in the field below times the total of the Project Direct and Indirect Costs only. Other Owner Costs are excluded.

A - GOLD adds the amount you enter below as this Owner Cost. Code A can only be used at the default Owner Cost Level.

C - GOLD computes the cost based on an escalation factor as defined in the Escalation fields below. Used only for the predefined Escalation column type.

EXHIBIT 18-4
8 OF 9

PRIME CONTRACTOR OVERHEAD AND PROFIT SCREEN

FUNCTION
HELP
ADD
TITLES
EDIT
DETAIL
LOOKUP
NOTES
SELECT
MENU
EXIT

PRIME CONTRACTOR

PROFIT WEIGHTED GUIDELINES

Risk	:	**0.000**	x	**20**	=	**0.00%**
Diff	:	**0.000**	x	**15**	=	**0.00%**
Size	:	**0.000**	x	**15**	=	**0.00%**
Period	:	**0.000**	x	**15**	=	**0.00%**
Invest	:	**0.000**	x	**5**	=	**0.00%**
Assist	:	**0.000**	x	**5**	=	**0.00%**
Subcon	:	**0.000**	x	**5**	=	**0.00%**
TOTAL				**100**		**0.00%**

SEPARATE O & P ON SUB'S

OVERHEAD	**PROFIT**
0.00%	**0.00%**
0	**0**

Bond Class : B

EXHIBIT 18-4
9 OF 9

MERGING MULTIPLE PROJECT DATABASES CHECKLIST

[ ] Project Databases must have the identical layout to Merge Correctly.

[ ] The Prime Cost Engineer created the agreed upon total project layout as determined in the MCACES GOLD user Manual.

[ ] Copy this newly created project layout to Project databases for each of the Cost Engineering disciplines that will be preparing their cost data separately. Each of these Project Databases are exactly the same at this point.

[ ] Each Cost Engineering discipline (including the Prime) shall edit their individual project Database and DELETE and PACK all System, Titles that are not applicable to their discipline.

[ ] Each Cost Engineering discipline (including the Prime) shall complete the quantity take-off following the same format that is in their Project Database.

[ ] After each discipline has completed their project and BEFORE merging, each project should be printed. Choose "Print Selected Reports" from the REPORTS Menu and print the individual project to be sure no database is corrupted and all errors have been corrected. You can send these reports to a file instead of the printer.

[ ] PACK the Project Database one final time before Merging.

[ ] The Prime Cost Engineer will collect the individual projects for merging into the Prime project. Make sure there is adequate hard disk space for EXTRACTING and MERGING project.

[ ] MAKE DUPLICATE COPIES of all Project Databases before beginning the EXTRACTING/MERGING process.

[ ] Carefully read the Merge and Extract functions in the MCACES GOLD User Manual.

[ ] Practice Extracting and Merging on small project databases to insure you understand the complete process.

[ ] Select the project Database to be Extracted and press (Enter) to open up the project.

EXHIBIT 18-5

[ ] Using (Shift) (F9) or Mark from the MARK Menu to mark Titles to be Extracted. Titles should be marked at the highest level applicable for the information to be Extracted.

[ ] From the MARKS Menu select "Extract To......." or press (Alt) (X) to begin the Extract function. This will create an identical database of the marked items in a unique filename. Write down the filename for later use.

[ ] Now select the Project Database where the extracted data is to be merged. Press (Enter) to open the database and choose "Merge From......" on the MARK Menu or press (Alt)(E). You will now be prompted to enter the path and filename you Extracted To above.

[ ] Examine the project to confirm that everything was merged properly.

EXHIBIT 18-5

CREATE A NEW PROJECT CHECKLIST

[ ] The correct databases (Models, Assemblies, Unit Prices, Crews, Labor Rates, Equipment Rates) are present in the Database Window.

[ ] The correct WBS Project Template has been selected.

[ ] The Project Template has been copied to new six character ID for this project.

[ ] The New Project has now been selected, and name of project edited.

[ ] The Report Title Page has been edited for this project.

[ ] The Project Information Record has been edited.

[ ] Prime and subcontractors have been edited.

[ ] The correct number of Facilities have been created.

[ ] The required Assembly Titles for all Primary and Support Facilities have been created and detailed items entered into the Assemblies.

[ ] All System, Subsystem, and Assembly Category Titles not required in this project have been deleted and the Project has been Packed.

[ ] All subcontractors not required in this project have been deleted and the Project has been Packed.

EXHIBIT 18-6

PRINT SUBMITTAL REPORTS CHECKLIST

[ ] All cost and pricing is entered based on the Current Design Status.

[ ] Costs for Systems and Subsystems not shown in the design have been accounted for in the estimate.

[ ] Titles (Facility, System, Subsystem, etc.) at all levels not applicable to this project have been deleted.

[ ] Prime Contractor's Field Overhead has been itemized to reflect project requirements.

[ ] Prime contractor's Bond has been set to calculate a Class B Bond.

[ ] Prime Profit has been calculated by the Weighted guideline Method and each factor assigned has been explained in the NOTES (F7) for the Prime Contractor.

[ ] Subcontractor's Overhead has been set as a percentage.

[ ] Subcontractor's Profit has been set as a percentage.

[ ] Prime and Subciontractors have been assigned at the appropriate locations within the project.

[ ] Any Subcontractors not applicable to this project have been deleted.

[ ] Sales Tax has been entered.

[ ] Escalations, Construction Contingency and SIOH have been set.

[ ] The project has been packed using Pack a Database from the SERVICES Menu.

[ ] The Mobile District Required Reports settings have been selected using Save/Load Report Settings from the REPORTS Menu, paragraph 6.b.

[ ] The printer has been set to print Landscape with 172 characters per line and 66 lines per page.

[ ] Estimate Status (35%, 60%, etc.) has been entered in the Report Title field or the Print Selected Reports Window.

EXHIBIT 18-7

[ ] Two hard copies of the Submittal Estimate have been made.

[ ] The Project Database & Labor Rates Database and any other database that the A-E added information to (Models, Assemblies, Crews, Equipment, etc.) have been Saved to Compressed to diskette from the SERVICES Menu.

CONTINGENCIES AND SUPERVISION & ADMINISTRATION

(USE THESE VALUES UNLESS DIRECTED OTHERWISE)

	ARMY	AIR FORCE
CONTINGENCIES		
NEW WORK	5%	5%
ALTERATIONS & MODERNIZATION	10%	10%
ADDITIONS/ALTERATIONS AND	10%	5% - IF ADD IS LARGEST 10% IF ALTERATION IS LARGEST
S&A (SIOH)		
NEW WORK	6.0% (CONUS) 6.5% (OCONUS)	6.0%
ALTERATIONS & MODERNIZATION	6.0% (CONUS) 6.5% (OCONUS)	6.0%
INSTALLATION SUPPORT	8.0% (CONUS) 8.5% (OCONUS)	N/A

CHAPTER 19

ENERGY AND ECONOMIC STUDIES

INDEX

CHAPTER 19

ENERGY AND ECONOMIC STUDIES

19.1 GENERAL.

19.1.1 Scope.

This chapter provides instructions to the Designer on the requirements for providing an energy efficient design and insuring that all designs are justified on a life cycle cost basis. Energy conservation features required in other sections of this document will be integrated into this project design unless the life cycle cost analysis indicates that other alternatives are more efficient.

19.2 APPLICABLE PUBLICATIONS.

Army Guide AEI — Architectural and Engineering Instructions, Design Criteria

Air Force Guide MIL-HDBK-1190 — Facility Planning and Design Guide

19.3 PROJECT DEFINITION (10-15%).

19.3.1 General Considerations.

(a) At the Project Definition phase the designer must define the customer's requirements and confirm that they can be met within the project's constraints. To that end, a comprehensive interface with the customer is required generally through a Charrette or other previously approved data gathering process. The primary purpose of the design process at this stage is to gather any information from the customer that would be necessary in the design of the facility. Also, the design preferences of the customer should be obtained for compliance if possible.

(b) The general mechanical system type will be estimated at the Project Definition phase for the purpose parametric cost estimate and required mechanical spaces.

19.3.2 Project Definition Narrative.

The Project Definition narrative shall include, but not be limited to, the following items as applicable:

(a) List all references used in the Project Definition design including Government design documents, industry standards, safety manuals, criteria given to designer at the Charrette or predesign meeting.

(b) List the computer program to be used to analyze the building and the general approach to the study.

(c) List the Energy Budget target figure and other parameters outlined in the applicable publications.

19.4 CONCEPT DESIGN (30-35%).

19.4.1 Concept Design Analysis.

A summary of the Energy Budget and Life Cycle Cost Analysis studies shall be submitted at the Concept design stage. Failure to submit a summary of the energy budget analysis and economic studies at the concept stage will require a resubmittal of the concept submittal. After review of the summary, the full set of calculations may be requested for review.

19.5 TECHNICAL REQUIREMENTS.

19.5.1 General Considerations.

(a) In order to meet mandated energy conservation goals, the Government has established Army Interim Design Energy budgets in BTU per square foot of building per year for each building category. It must be emphasized that the energy budget analysis is an exercise to obtain a relative level of energy efficiency for the building envelope and is not intended to determine actual overall energy usage as would be determined for life cycle analysis. Heating and cooling requirements shall be only those to maintain comfort conditions without any process loads. Lighting loads shall be only those for general lighting, and hot water heating shall be only that required for personal use. Unless all parameters (schedules, loads, etc.) are identical to those used in the life cycle analysis, the energy budget is required to be derived via independent energy calculations, computer runs, etc. The general guide for energy budget studies shall be the Architectural and Engineerin Instructions, Design Criteria for Army projects and MIL-HDBK-1190 Facility Planning and Design Guide for Air Force projects. If there is question on design guidance, the Mobile District Mechanical Section will provide the needed instructions.

(b) Computer Analysis: This entire facility must be fully analyzed through a sophisticated hour-by-hour computer program which will incorporate annual weather data, i.e., Trane TRACE, BLAST, or Carrier HAP.

(c) Qualification of Design Personnel: The energy budget and economic studies must done by a registered professional engineer who is experienced in performing such studies.

(d) Team Approach: The effort to design a facility within its design energy budget cannot be achieved by mechanical design alone but can only be achieved by a joint or "team effort" of all design disciplines. Equal emphasis should be placed on the architectural and electrical features in addition to HVAC systems to achieve an energy efficient building. All aspects of energy conservation shall be considered.

(e) A summary of the economic studies based on life cycle cost analysis procedures comparing alternative building systems must be submitted before construction is begun. Only alternatives which can meet the energy budget target should be considered. Thus, the selected concept will be the most economical approach that will meet the energy budget target.

(f) The economic studies shall be performed utilizing methodology defined therein and Architectural and Engineering Instructions, and MIL-HDBK-1190.

(g) The following decisions should generally be supported using life cycle cost analysis:

1. Heating and cooling load reduction (architectural and electrical features).

2. Fuel selection.

3. Building system type.

4. Equipment type.

5. Equipment efficiencies.

6. Design parameters affecting operating efficiency (chilled water temperature, delta T, ambient conditions for selection of cooling towers, condensers, etc.).

(h) Designers are responsible to determine the most Life Cycle Cost Study (LCC) effective selection from among the viable alternatives available. Designers also are responsible to minimize the level of effort necessary in arriving at that determination. The following should be considered whenever a LCC analyses is anticipated:

1. Make maximum use of previous or generic LCC analyses. Revise only as necessary to apply to a new design or situation. Do not generate a new LCC analyses unless absolutely necessary for the application.

2. Only consider viable alternatives that will provide good performance, meet the functional requirements of the building, and meet the needs and expectations of the customer. For example, don't consider a heating and cooling system with complex controls if the installation does not have a reasonable capability for providing maintenance after it has been installed. If only one viable alternative exists, there is no further need to consider a LCC analyses. In applying the principles of life cycle cost analyses, common sense and the capabilities of designers should be combined to arrive at the most feasible and economic selection for the application at hand.

CHAPTER 20

ENERGY MONITORING AND CONTROL SYSTEMS (EMCS)

INDEX

CHAPTER 20

ENERGY MONITORING AND CONTROL SYSTEMS (EMCS)

20.1 GENERAL.

There are three Emergy monitoring and control systems (EMCS) alternatives which may apply to a project:

(a) No EMCS provision.

(b) Provisions for future EMCS.

(c) Facility preparation for future connection to existing EMCS.

The appropriate alternative for the project should be clearly established at the predesign conference. If no provisions are to be made, that fact should appear in the minutes of the predesign conference and in the design analysis of the concept submittal.

20.2 APPLICABLE PUBLICATIONS:

The publications listed below are those required for this section. Applicable publications which apply to specific electrical and mechanical equipment associated with EMCS (air handling units, electric meters, etc.) are included in the respective sections of this manual.

Guide Specifications:

SECTION 13814	Building preparation for EMCS
SECTION 13820	Muiti-building expansion of EMCS

National Fire Protection Association (NFPA)

NFPA 70	National Electrical Code

Technical Manuals:

TM 5-815-2	Design Manual for EMCS

20.3 DESIGN OF PROVISIONS FOR FUTURE EMCS.

(a) New Facilities: At installations where there is no existing operational EMCS, provisions for the future connections of the project to an EMCS shall be included in the design. These designs include the following:

1. Future Cabinet Locations: Select and reserve clear wall spaces 3-feet wide in all mechanical rooms. Reserve enough depth in front of those spaces for future compliance with the clearance requirements of NEC Article

110 after an 18-inch deep EMCS cabinet is mounted on the wall.

2. Empty Conduit: Install the following empty conduits stubbed up, capped, and containing pull wires:

a. Between the future-panel space in the main mechanical rooms (or communication equipment room, if the project has one) and the future-panel spaces in any other mechanical rooms within a building. Conduit diameter size = 1-1/2 inches.

b. From all equipment mounted outdoors (such as cooling towers, packaged HVAC units, etc.) to future-panel space in the nearest mechanical room. Conduit diameter size = 1-1/2 inches.

c. From the future-panel space in the main mechanical or communication equipment room to the location of the telephone conduit entrance. Conduit diameter sizes = 1-1/2 inches.

d. From each electrical, oil, or gas meter to the nearest mechanical room. Conduit diameter should be 3/4 inches.

3. Auxiliary Contacts: Provide auxiliary contacts in the following and similar equipment for status indication:

a. Boiler and furnace controllers.

b. Burner controls for oil/gas domestic water heaters (where externally-powered burner controls are provided).

c. Contractors for electric domestic water heaters (where contractors are provided). There is no need for auxiliary status contacts in starters for supply air, return air, exhaust fans, pump motors, or similar applications, because differential pressure or flow switches will be used for status indication in those applications if the building is to be connected to an EMCS in the future.

4. Pressure Taps: Provide 1/4-inch, Schedule 80, half-coupling capped pressure taps with gage cocks at the suction and exhaust sides of pumps for the future installation of differential pressure switches. Pressure taps should be incorporated with the taps provided for pressure gages where possible.

5. Sensor Wells: Provide wells for temperature sensors in the piping of boilers, heat exchangers, chillers, etc. Wells for the future EMCS sensors should be near those for the local indicators.

6. Gas Meters: Gas meters without pulsing devices will be provided at installations that do not have an operating EMCS system. These meters will be of the type which can be adapted to a future EMCS system by the addition of a pulsing device.

7. Specifications: Do not use a separate specification section for the future EMCS provisions; instead, incorporate specifications for the

provisions into appropriate mechanical and electrical sections.

(b) Alterations and Additions to Existing Buildings: In alteration /addition projects at installations where future provisions are to be made, the above guidance shall be followed to the extent permitted by existing conditions and good engineering practice.

(c) Submittal Requirements for Future Provisions:

1. Project Definition Requirements (10-15%).

a. At the Project Definition design stage of project development, a statement is required which indicates the intent of designer to provide an EMCS system or provide for a future connection to an existing EMCS system.

2. Concept Submittal Requirements (30-35%:

a. Design Analysis: Document the fact that only provisions for future connection will be made. List any problems or questions.

b. Drawings: On the Mechanical and Electrical floor plans, show the spaces reserved for future panels. Show a riser diagram on the Electrical plans.

3. Interim Submittal Requirements (50-60%):

a. Design Analysis: This analysis is an extension of the approved comments and should confirm that the Mechanical and Electrical features have been coordinated.

b. Interim Design Drawings and Specification: The interim drawings are an extension of the approved concept drawings and are to address the concept comments.

(1) Ensure that all details have been included on the drawings.

(2) Thoroughly check for discrepancies/ compatibility between drawings and specifications, and between disciplines.

(3) Do not prepare a separate specification for the EMCS provisions. Include specifications for items such as pressure taps, sensor wells, conduits, etc., in the appropriate mechanical and electrical specifications. Provide specifications for items that the Guide Specifications do not adequately cover.

(4) Coordinate all drawings and check for the following:

a. Verify consistency between disciplines (equipment locations, plans, and specification).

b. Ensure the legend and/or symbols are complete and compatible with all drawings.

c. Verify that all plans (especially risers diagrams) and specifications are complete, meet criteria, and do not contain conflicts.

4. Final Design Submittal Requirements (Unreviewed 100%:

a. Final Design Analysis: This analysis shall be complete and shall support the requirements of the project.

b. Final Design Drawings and Specification: The drawings and specificaitons shall be complete and thoroughly checked. All approved comments will be implemented.

5. Ready-to-Advertise Submittal Requirements (100%:

a. Ready-to-Advertise Design Analysis: This analysis shall be complete and shall support the requirements of the project.

b. Ready-to Advertise Design Drawings and Specification: The drawings and specifications shall be complete and thoroughly checked. All approved comments will be implemented.

20.4 FACILITY PREPARATION DESIGN FOR OPERATIONAL EMCS.

For projects at installations having an existing operational EMCS, guidance contained in this section shall apply for all new facilities. For renovation/addition projects, this guidance shall be followed to the extent permitted by existing conditions and good engineering practice. The procedures for Army and for Air Force projects are as follows:

Army: A decision will be made at the predesign meeting by the Using Agency or the Corps of Engineers, Mobile District on whether or not an EMCS system will be required for the facility.

Air Force: The designer shall design building preparation for all application programs which can be utilized by the facility in accordance with TM 5-815-2.

(a) Follow guidance contained in the APPLICABLE PUBLICATIONS, and the following:

1. Provide a Data Terminal Cabinet (DTC) and enough space adjacent to it for the future installation of the field interface device (FID) or multiplexer (MUX) that will be installed under the expansion contract. (The expansion contract will be prepared by an EMCS specialist, and is not a part of the A-E's facility design.) The location of the DTC must be such that the installation will comply with NEC Article 110 after the FID or MUX has been installed.

2. A 120-volt, duplex outlet shall be located next to the DTC.

3. Conduit for the future installation of the data transmission media (DTM) shall be run from the future FID or MUX location to the point where the DTM will enter the facility.

4. Conduit and wiring shall be run from the DTC to each utility meter. For metering requirements, see applicable chapters in this Manual.

5. All input and output points required by the application programs shall be installed and wired through conduit back to the DTC.

(b) Drawings: Show the location of the DTC on both the Mechanical and Electrical drawings. Show the input and output points on the control schematics of the Mechanical drawings and the installation on the equipment connection details. All conduit runs to input/output points shall be specified on the Electrical or Instrumentation drawings. The location of any points (such as space temperature sensors) not shown on the Mechanical drawings shall be shown on the Electrical or Instrumentation drawings.

(c) Specifications: Tailor applicable specifications making sure that the specifications and drawings agree. Prepare I/O Summary Tables in accordance with TM 5-815-2, Energy Monitoring and Control Systems, and include them as a continuation of the specifications or on the drawings.

(d) Cost Estimate: The estimated costs of the facility preparation shall be included in the cost estimate of the basic contract.

(e) Submittal Requirements for Building Preparation:

1. Project Definition (10-15%): At the Project Definition design stage of project development, a statement is required which indicates the intent of designer to provide an EMCS system or provide for a future connection to an existing EMCS system.

2. Concept Design (30-35%), Air Force Only:

a. Design Analysis: The design analysis shall include the following:

(1) A statement that the project design will cover building preparation for future connection to the existing EMCS.

(2) Identification of all equipment to be monitored and/or controlled.

b. Drawings:

(1) Exterior work--to be shown on electrical site plan.

a. Existing and new communications services, both overhead and underground, shall be properly identified.

b. Show removals and relocations, if any.

c. Removals or Demolition: For work requiring removals or demolition, the Designer shall show, by use of drawings or narrative, how demolition work is to be done.

d. Additional Criteria: Any additional criteria, deviations concerning criteria or questions should be listed.

3. Interim Design (50-60%):

a. Design Analysis: Update the concept analysis on the drawings. Show locations of all input/output points, and show conduit from input/output points to DTC.

b. Drawings: Show the facility preparation details on the drawings. Show empty conduit for DTM from DTC to building exterior. Show locations of all input/output points, and show conduit from input/output points to DTC.

4. Final Design (Unreviewed 100%):

a. Final Design Analysis: This analysis is an extension of the approved interim design analysis and supports and verifies that the design complies with the requirements of the project.

b. Final Design Drawings and Specifications: The final drawings are extensions of the approved Interim drawings and are to include the Interim comments.

(1) Ensure that all details have been included on the drawings.

(2) Thoroughly check for discrepancies/ compatibility between drawings and specifications, and between disciplines.

(3) Submit complete marked-up Guide Specifications. The specifications or the drawings shall include I/O summaries. The specifications must be coordinated with the drawings and describe in detail all items and systems shown on the drawings.

(4) Graphic diagrams (see Chapter 4 of TM 5-815-2) may be included in the specifications or the drawings. These diagrams, the I/O summaries, and the Mechanical and Electrical drawings must be closely coordinated to eliminate discrepancies and conflicts.

(5) Cost Estimate: The cost estimate for the building preparation shall be included in the facility cost estimate.

5. Ready-to-Advertise (100%):

a. Ready-to-Advertise Design Analysis: This analysis shall be complete and shall support the requirements of the project design.

b. Ready-to-Advertise Design Drawings and Specifications: The drawings and specifications shall be complete and thoroughly checked. All approved comments shall be implemented in the plans and specifications.

Appendix A

Pumping Station Design Considerations

1. GENERAL

The designer shall incorporate the following considerations and instructions into the design of a pumping station. These considerations are in addition those employed in the normal design process.

2. APPLICABLE PUBLICATIONS

a. EM 1110-2-3102 *General Principles of Pumping Station Design*
b. EM 1110-2-3104 *Structural and Architectural Design of Pumping Stations*
c. EM 1110-2-3105 *Mechanical and Electrical Design of Pumping Stations*

3. ARCHITECTURAL

a. Handicapped access: Pumping stations intended for public access shall be fully ADA compliant for wheelchair access. Stations not open to the general public shall include wheelchair access to the office and bathroom only. Office access may be in the form of an equipment or vehicle ramp.

b. Security: Provide bullet-proof doors, windows, and louvers.

c. Truck access: For pumping stations used primarily for flood control, provide room for a pick-up truck to be parked inside the station superstructure (building). For water supply stations, only provide sufficient room for the truck bed within the superstructure, to allow placement of equipment on the truck bed using the overhead crane.

d. Access hatches: Provide a hatch in the service bridge to allow a dewatering pump into the pump bay. Provide a hatch to allow personnel access into the sump bay.

e. Crane travel: Coordinate overhead crane travel with target lift items to avoid interference with walls or other equipment. Provide a plan that indicates the overhead crane coverage limits.

f. Sound insulation: Where offices are used, provide sound insulation for office walls sufficient to limit noise levels to a maximum of 85 decibels. Investigate use of well-insulated doors and weather-stripping.

g. Windows: Where offices are used, provide an office window to view the operating floor area.

h. Accessories: Where offices are used, provide space for a refrigerator and a microwave oven.

4. STRUCTURAL

a. Structure type: Structures shall be fully enclosed, unless the service life is 10 years or less. In general, pumping stations used primarily for flood control will include both an office and restroom. Avoid use of masonry block construction for the superstructure. Consider concrete or steel framing systems.

b. Roof hatches: Superstructure roof hatches located directly above the pumping assemblies allow the pumps to be extracted with minimal disassembly. Pumping stations primarily used for flood control, that will be manned during a flood event, will not include roof hatches. For stations used for unmanned flood control or water supply structure, roof hatches are optional. Where roof hatches are used, the facility shall be designed with respect to capacity of cranes planned for use in pump extraction.

c. Service bridge dimensions: The minimum clear bridge width is 14.0 ft. Where dewatering needles slots are within the bridge deck, the minimum distance between the slots and the trash rake/rack assembly is 14.0 ft. An alternative to this clearance is the use of needles that, once installed, allow the replacement of the slot cover grating.

d. Design criteria.

(1) Service bridge: The service bridge shall be designed for a heaviest expected axle load arrangement during construction or service. Construction equipment loads can significantly exceed AASHTO HS-20 truck loads.

(2) Substructure: The substructure is considered a hydraulic control structure. Use EM 1110-2-2104, *Strength Design for Reinforced Concrete Hydraulic Structures*, for substructure and operating floor design.

(3) Superstructure: The superstructure is not considered a hydraulic control structure. Use ASCE 7-98, *Minimum Design Loads for Buildings and Other Structures*, for wind loading on the superstructure. Use appropriate concrete or steel design code provisions.

5. MECHANICAL

a. Pump bay/sump width: Bay width shall be calculated in accordance with EM1110-2-3105 and ETL 1110-2-313, and rounded up to the nearest whole foot.

b. Pump considerations:

(1) Intake type: For adverse upstream flow conditions, use formed suction intakes (FSIs). Also, consider FSIs for single pumps with capacities in excess of 500 cfs. For standard suction bell intakes, the dimensions of the sump shall be in accordance with Chart B-2 in Appendix B of EM 1110-2-3105 and ETL 1110-2-313.

(2) Backflow prevention: Provide both normal and back-up means of backflow prevention in pump discharge lines when backflow can occur without siphon action.

(3) Flap gates: Provide a mechanical means to support the flap gates when pumps will be operated for extended periods of time.

c. Engine and reduction gear considerations:

(1) Cooling: Optimize the airflow across the engines. Consider grating in the floor around the pumps and engines so that cooler air can be drawn in over the engines. (Note that plates shall also be provided in lieu

of grating when not pumping during cold weather.) Consider exhaust fan location in the upper walls.

(2) Engine rating: Engine pump drives will to be continuous rated.

(3) The clear opening between bars in a trash rack should not exceed 3 inches in any case. Bar spacing should be coordinated with the pump manufacturer through the specifications.

(4) Reduction gear rating: Assign reduction gear application factor of 1.75 (electric motor) and 2.0 (diesel engine), assuming severe operating conditions, to increase reliability.

d. Hood location: Consider exterior mounted hood and roll-up doors for the air intake louvers to reduce rain infiltration.

e. Fuel supply: Provide separate fuel supply lines from the day tanks to the engines and generator. Consider using separate day tanks for each engine and generator.

f. Hydraulic line location: Place all hydraulic lines on the outside of the electrical and controls cabinets.

g. HVAC: Only offices, where used, will have air-conditioning. Air-conditioning units shall consider all heat sources, including mechanical heat sources. Use of a split system room unit, where minimizes the size of the wall penetrations should be considered. Over-sized air-conditioning units can cause moisture problems.

h. Water heater: For pumping stations used primarily for flood control, provide a water heater for use with the shower and sink. For non-flood control pumping stations, use of water heaters is optional, based on the likelihood of freezing weather.

i. Stilling wells: Provide intake and discharge stilling wells that satisfy user requirements. The stilling wells will contain only the basic well and any necessary conduit. The water level sensor and other electronic components of the stilling well will be provided and installed by the user.

j. Trask rakes: Use an overhead monorail types (manufactured by Kuenz America and Bosker/Brackett Green) for pumping stations with a capacity in excess of 1000 cfs. Use front-cleaning, chain driven trash rake assemblies, fixed to the rack, for stations with a capacity less than 1000 cfs.

6. <u>ELECTRICAL</u>

a. Remote operation: Provide all engines, motors, and the ventilation system with electrical relays and controls for remote operation. Future telemetry systems will be installed the user. Incorporate terminal blocks, local wiring, etc. in accordance with user-furnished requirements. Provide engine and pump status lights to indicate pump stop, start, and running condition. Include a remote-off-local selector switch with each engine.

b. Emergency generator type: The emergency generator must include LPG leak detection.

c. Lighting:

(1) Locate lights on all four sides of the pumping station, with each side on a separate circuit. Provide a light on a photocell at the primary entrance to the station.

(2) For pumping stations used primarily for flood control, provide office wall receptacles and lighting, powered by an emergency generator, for use in storm events.

d. Instrumentation:

(1) Provide separate local and remote controls and monitoring of the engine and electric motor pump drives.

(2) Provide off-the-shelf controllers and diagnostic software.

(3) Use solid-state starters for the electric motor pump drives only.

(4) Ensure, by testing, that the engine governor allows the engine to increase in speed no more than 2% except in sudden loading or unloading of the engine.

(5) Where an office is used, provide an office terminal to allow the operation of pumps and observation of the engine temperatures, pressures, etc., from within the office.

7. APPURTENENT

a. Dewatering needles: Needles shall be standardized to one, two, three or four foot nominal widths. Adequate installation clearance, particularly for sloped installations, must be verified.

8. PERMITS The construction contractor will secure permits for the fresh water well and septic tank. Design a retention pond, if required, in accordance with South Florida Water Management District's *Permit Information Manual, Volume IV - Management and Storage of Surface Water*. No stormwater related permit will be required.